

## Assessing Metacognition: Theory and Practices

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### Abstract

Many researchers in education emphasized students' metacognition should be fostered for academic development and achievement. However, to support students' metacognitive development and adequacy appropriately, their metacognition is to be assessed first. For this purpose, this theoretical study conducted a short review of metacognition, its assessment, and limitations of assessment measures and procedures. By focusing on ten current studies, a pattern of metacognition assessment was portrayed. It was concluded that knowledge about and regulation of cognition was assessed simultaneously as metacognition theory proposes. To assess especially knowledge about cognition, exclusively off-line measures were used. For regulation of cognition, both off-line and on-line measures were used. Chronological analysis of these studies revealed that latest metacognition assessment studies tended to utilize domain-specific or real-life tasks. Based on the findings, research implications for assessment and instruction were laid down.

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### 1. Introduction

Educating metacognitive individuals is one of the primary objectives of today's major initiatives since in 21<sup>st</sup> century, students should be able to build strong content knowledge by responding to varying demands of audiences, tasks, purposes, and disciplines by critically synthesizing different resources and valuing sound evidence. However, without metacognitive assessment that can provide with diagnostic information and directions for its instruction, educational initiatives seem to take students' metacognitive development or adequacy unreliably for granted.

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This paper, thereby, focuses on assessing metacognition to contribute to its instruction. For this purpose, conceptual definitions and a short review of metacognition theory will be presented initially to disseminate the focus of assessment. Next, common procedures and measures used to assess metacognition and some limitations will be presented because they may confound interpretations. Then, recent research studies on assessing metacognition will be reviewed analytically to detect whether and how metacognition theory is exercised for assessment purposes. Finally, possible future research and implications for metacognition assessment and instruction will be discussed.

### 1.1. Conceptual Definitions

The definition of metacognition has important implications for its assessment considering the construct validity. The common conceptualization of metacognition pertains to knowledge about cognition and regulation of cognition (Flavell, 1979). To create the framework for this paper and for the studies to be selected, this paper adopted Block's definition of metacognition assessment. According to Block (2006), metacognitive assessment pertains to assessing "reader's awareness and knowledge of the mental processes engaged during reading... [and] if a reader can monitor, regulate, and direct their thoughts before, during, and after reading to obtain a complete comprehension of text" (p. 84). Expanding this definition on learning in general, this paper defines metacognition assessment as assessing individuals' knowledge about and regulation of cognitions (planning for the task, monitoring one's performance, regulating skills, and evaluating performance and goal fulfilment). In the following, the fundamentals of these definitions will be elaborated.

## 2. Metacognition and Components of Metacognition

Jacobs and Paris (cited in Michalsky, Mevarech, & Haibi, 2009) described metacognition as "the conscious self-awareness of one's own knowledge of task, topic, and thinking, and the conscious self-management (executive control) of the related cognitive process" (p. 364). Almost 30 years later, Veenman, Van Hout-Wolters, and Afflerbach (2006) defined metacognition as "a higher-order agent overlooking and governing the cognitive system, while simultaneously being part of it" (p.5). Veenman et al. (2006) argued that if metacognition is a set of self-instructions to regulate task-performance, then cognition is the vehicle for these self-instructions. In order to understand this two-way mental processing and to conceptualize metacognition better, Nelson's (1996) Metacognitive Model of consciousness and cognition can be studied. Nelson (1996) distinguished "object-level" (cognitions concerning external objects) and "meta-level" (cognitions concerning cognitions of external objects) processes and by his Metacognitive Model, it was highlighted that "any lower-level cognition can itself be the subject of a higher-level cognition" (Nelson, 1996, p. 105). That is,

[i]nformation about the state of the object-level is conveyed to the meta-level through monitoring processes, while instructions from the meta-level are transmitted to the object-level through control processes. Thus, if errors occur on the object-level, monitoring processes will give notice of it to the meta-level and control processes will be activated to resolve the problem (Veenman et al., 2006, p. 4).

To understand these definitions and conceptualizations better, components of metacognition needs dissemination. *Knowledge about cognition* pertains to thinking and sensitivity to act accordingly (Flavell, 1979). It includes "students' declarative, procedural, and conditional

knowledge about cognition, cognitive strategies, and task variables that influence cognition” (Pintrich et al., 2000, p. 45). Declarative knowledge pertains to one’s awareness of *what* influences cognitions and includes person, task, and strategy variables (Veenman et al., 2006). Procedural knowledge pertains to a large variety of strategies or skills (Pintrich, Wolters, & Baxter, 2000; Pressley, Borkowski, & Schneider, 1987; Veenman et al., 2006) and it reflects “an appreciation for *how* skills operate or are applied” (Cross & Paris, 1988, p. 131). On the other hand, conditional knowledge pertains to one’s knowing *when* and *why* to use declarative and procedural knowledge (Garner, 1990).

Metacognition also includes *regulation of cognition*. It is generally categorized into three: planning, monitoring and regulation, and evaluation (Ozturk, 2016; Schraw, 1998). Planning pertains to goal-setting that guides cognitions in general and monitoring specifically (Pintrich et al., 2000). Although it is not easy to separate monitoring and regulating from each other during a task performance, these activities can be distinguished conceptually as in the following (Pintrich et al., 2000). Monitoring activities include assessing learning and performance-in-action while regulation pertains to changing cognitions and behaviour to match them with personal goals and task demands (Pintrich et al., 2000). Evaluation, lastly, pertains to “appraising the products and efficiency of one’s learning” by re-visiting one’s goals and conclusion (Schraw, 1998, p.115). However, although these facets are described separately here, it is important to recognize that knowledge about and regulation of cognition relate and have an interactive nature (Veenman et al., 2006).

### **3. Assessing Metacognition**

In literature, metacognition is assessed by different procedures and measures. In the following, common measures and procedures will be disseminated with regards to metacognition components.

***Knowledge about cognition:*** Measures assessing knowledge of cognition can look similar to standard tests because knowledge of cognition is considered much like knowledge stored in memory (Pintrich et al., 2000). That is, individuals tell whether they know or do something or not. Baker and Cerro (2000) identified interviews and/or questionnaires as one of the most frequently used methods to assess metacognitive knowledge. Metacognitive Awareness of Reading Strategies Inventory (MARSİ), for example, was developed to assess domain specific metacognition. Mokhtari and Reichard (2002) designed MARSİ to assess adolescent and adult readers’ metacognitive awareness and perceived use of reading strategies; global reading strategies, problem-solving strategies, and practical support strategies. On the contrary, Metacognitive Assessment Inventory (MAI), developed by Schraw and Dennison (1994), is used to measure adults’ general metacognitive knowledge and regulation of cognition. These instruments are examples of off-line measures as they can be administered effectively to large groups and scored easily.

***Regulation of cognition:*** To measure metacognitive judgements, monitoring, and regulation, on-line processes are used. By these measures, individual are asked what they do and think before, during, and after a cognitive task. Procedures such as “detection of errors in passages; ratings of felt understanding; self-corrections during oral reading; completion of cloze tasks; on-line measures of processing during reading (e.g. eye movements and reading times); and

retrospective or concurrent verbal reports (e.g. thinking aloud)” can be used to assess individuals’ regulation of cognition (Baker & Cerro, 2000, p.102).

To measure metacognitive monitoring, self-report judgments can be used (Pintrich et al., 2000). Before individuals perform some tasks, they can be asked to rank how easy the information will be to learn. Then, after given some tasks and study trials, individuals can be required to rank and make a judgment of their learning. Because individuals’ confidence in their performance is assessed by comparing it to their actual performance, the accuracy of their judgements relates to their monitoring ability (Pintrich et al. 2000). That is to say, students who felt they know something and did, and students who felt they did not know something and did not are both considered good monitors as they can make accurate judgements.

Regulation can be assessed by several different questionnaires and interview protocols such as the Learning and Study Strategies Inventory (LASSI), the Motivated Strategies for Learning Questionnaire (MSLQ), the Self-Regulated Learning Interview Schedule (SRLIS). The MSLQ and LASSI ask individuals to respond to Likert-type items for their domain- general and domain-specific cognitive strategy use and regulation of cognition, respectively. The MSLQ is designed to assess rehearsal, elaboration, organization, and critical thinking while metacognitive monitoring and self-regulation are assessed on a 12-item scale apart from resource management strategies (Pintrich et al., 2000). Moreover, the SRLIS asks individuals about self-regulation considering specific tasks. After individuals are presented some descriptions of the content, they are asked how they would behave during a) a classroom discussion, b) short writing assignment, c) mathematics assignment, d) end-of-term test, e) homework assignment, and f) studying at home (Zimmerman & Martinez-Pons, cited in Pintrich et al., 2000). The responses are categorized into knowledge, monitoring behaviour, strategy use, and regulation. Similarly, Survey of Reading Strategies (SORS), developed by Sheorey and Mokhtari (2001), intends to measure the perceived use of strategies while reading academic materials. On a 5 point Likert-scale, individuals are asked to indicate the frequency of reading strategy use.

Veenman (2005) categorized measures for cognitive regulation into three as prospective, concurrent, and retrospective measures. Collected before a learning task, prospective measures aim at identifying metacognitive skills either in general or prior to specific learning tasks. Veenman (2005) stated that questionnaires can be used for this purpose and individuals can be asked to indicate to what extent and/or how often a statement represents their study behavior on for example, a Likert-scale. Apart from questionnaires, Veenman (2005) also appreciated interview techniques as a form of prospective measures. By structured or hypothetical interview procedures, individuals can be assessed for their strategy usage. While their answers are coded, the number of the strategies and metacognitive merit can be evaluated (Veenman, 2005).

Concurrent measures help collect data during individuals’ task performance. A predominant method for assessing metacognitive skills is the analysis of think aloud protocols (Veenman, 2005). The basic principle of think aloud is that “participants are instructed to merely verbalize their thoughts during task performance. Only in case they fall silent, the assessor may urge them to “keep on talking” (p.80). Think aloud protocols can specifically be utilized for assessing individuals’ monitoring of the text characteristics, understanding, problems in comprehension, and their strategic processes used to comprehend text (Pressley & Afflerbach, 1995). Think aloud processes are transcribed verbatim and analysed according to a coding scheme, resorting exclusively to the quantity of metacognitive activities and the quality of metacognitive processes. The protocols are generally analysed by two or more judges separately for inter-rater reliability.

In relation to evaluation and judgements of metacognitive activities, Veenman (2005) especially warned the assessors not to confuse correctness of knowledge to mindfulness.

Veenman (2005) also highlighted systematical observations can be used to assess metacognitive skills. The observations are made by the judges who are physically but unobtrusively present during task performance. Judges can also watch videotapes afterwards to score individuals' metacognitive behaviours if there are concerns related to their presence within the site. Often used with young children, on-line observations can only account for quantitative behavioural assessment, not for the metacognitive objectives. As in the case of think aloud, a coding scheme should describe all possible metacognitive activities to be evaluated.

The error detection paradigm is another approach to assess metacognitive skills (Baker & Cerro, 2000). Individuals are presented with texts that contain problems and/or errors and their metacognitive ability is inferred from their attention to the embedded errors. The underlying assumption of this paradigm is that these problems or errors disrupt comprehension and the readers who monitor their comprehension notice them. Baker and Cerro (2000) stated whether readers are capable of detecting the errors can be assessed by performance measures such as underlying errors, verbal reports during reading, and on-line measures like eye-tracking.

Retrospective measures, on the other hand, are administrated just after a performance has been completed. Due to the risk of memory failure and distortions, stimulated-recall technique that requires participants to review a video of their own performance can be used to help individuals with the reproduction of their thought processes during their task-performances (Veenman, 2005).

#### **4. Limitations of Current Assessment Approaches**

Assessing metacognition is important but simultaneously it is challenging (Schraw, 2000). Despite numerous measures and procedures developed to meet this assessment challenge, metacognition that is a multi-layered complex phenomenon may not be easily assessed. While measures of metacognitive knowledge do not tap into metacognitive monitoring or regulation, metacognitive judgements and monitoring measures are not consistent in assessing the same components (Pintrich et al., 2000). Furthermore, regulation is commonly assessed rather than monitoring (Pintrich et al., 2000; Pressley & Afflerbach, 1995).

With regards to previously mentioned procedures and measures, some limitations will be discussed in the following. One of the frequently used methods, verbal reports possess some limitations which should not be ignored for accurate interpretations. During the interviews, it is possible that individuals do not understand the questions and do not ask for clarifications, or they may not be willing to express their genuine thoughts and experiences (Baker & Cerro, 2000). Their responses, therefore, might be indecisive and socially desirable ones. Moreover, as Veenman (2005) argued, it is never for sure whether the respondents have metacognitive strategies and skills at their disposal or they can really use them when appropriate even though they can report the relevance. Also, as Pintrich et al. (2000) stated that although participants can be asked for a number of strategies during the interviews, they may not include domain-specific control and regulation strategies. In addition to these limitations, some concerns with interpretation cannot be ignored. As Whitebread and colleagues (2009) emphasized, interpreting self-reports and scoring especially open-ended questions is not an easy task. Such a task requires not only expertise in data analysis, but it also requires expertise with metacognition theory and its practical applications.



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Regarding questionnaires, Veenman (2005) stated that although they are relatively easy to administer, questionnaires do not reliably describe metacognitive behaviour. Reviewing 21 questionnaire studies, Veenman and van Hout-Wolters (as cited in Veenman, 2005) also stated that the predictive value is low; the mean variance accounted in learning outcomes was around 3%. Students' individual reference points may cause this low predictive value because students might compare themselves with the best or poorest classmates. Moreover, as Veenman (2005) and Pintrich et al. (2000) stated, measuring and evaluating skills through questionnaires is a very controversial issue. Not only can questionnaire items portray individuals' adequacy with regulation of cognition, but also the representativeness of such questionnaires might be problematic regarding the limited number of items on questionnaires. For these reasons, reliability, construct and structural validity, mismatch between theoretical models of metacognition and subcomponents requires careful interpretations. Moreover, generalizability of these measures might be problematic considering diverse students characteristics (Pintrich et al., 2000).

Furthermore, there are limitations with think-aloud protocols. While think-aloud aims to understand metacognitive and cognitive processes, it is important to remember that these processes cannot be always accessible to consciousness. Individuals may not be always aware of their knowledge, monitoring, or regulation or their verbal proficiency might not be adequate to describe these. Think aloud may also slow down or interrupt cognitive processing and might limit some individuals' working memory capacity (Baker & Cerro, 2000; Lai, 2011; Veenman, 2005). Although all these factors can be controlled well enough, still personal and/or affective factors (such as motivation, anxiety, self-esteem, verbal ability, age, expertise, and individuals' knowledge) might interfere with individuals cognitive processing (Baker & Cerro, 2000; Pintrich et al., 2000; Schraw & Moshman, 1995). Therefore, there is a risk that interpreting think-aloud procedures might underestimate metacognitive capacity (Lai, 2011). To recognize confounds in disguise, think-aloud protocols should be scored by judges with sufficient expertise and experience with metacognition theory.

Furthermore, in spite of providing some evidence for on-line comprehension monitoring, error detection paradigm has limitations. First of all, Baker and Cerro (2000) emphasized that depending on readers' being informed about the problems in the text, differences in their comprehension monitoring can occur. Also, reliance on verbal-reports, as mentioned beforehand, might not always be trustworthy. In addition, as readers might use variety of criteria for detecting errors and evaluating their understanding, problems that individuals report might be completely different than those intended to be conveyed. However, failure to notice particular problems in a text does not necessarily portray poor comprehension. Moreover, error detection paradigm is also criticized for ecological validity; individuals do not normally read texts embedded with errors. Although individuals' monitoring strategies can be assessed by the error detection paradigm, it is not for certain whether these individuals monitor their comprehension under normal conditions without any stimuli like texts used for error detection.

Systematic observations, which are somewhat independent of confounds like individuals' verbal ability and working memory capability, still have limitations. Considered to be more ecologically valid compared to the previous paradigms (Lai, 2011), observations need to be converged with other measures for construct validity (Veenman, 2005). This is because it cannot assess metacognitive intentions for performing certain behaviours (Veenman, 2005). Although systematic observations are considered to take social processes of learning into consideration and embedded in the context of instruction, the judgment is limited to the observants' inferences. Even

the construct of metacognition is standardized and checklists are developed, because of social influence and other contextual factors, the inferences derived from metacognitive assessment might not be always accurate.

Lastly, stimulated-recall technique holds drawbacks in assessing metacognitive skills. This is basically due to the time lag between individuals' actual performances and their verbal reports. When participants watch their own performances, it might be difficult for them to reproduce memory traces and covert mental activities. Therefore, instead of correct recollections, reconstructive interpretations may be elicited (Veenman, 2005). As Nisbett and Wilson (cited in Veenman, 2005) stated, even retrospective verbal reports of higher order processes might lack accuracy because participants might tell more than they know.

The limitations of particular approaches covered in this theoretical study pertain to individuals' working memory capacity, verbal proficiency, personal performance criteria, tendencies towards socially desirable responses, observant' expertise and interpretation biases, and measures', procedures', and interpretations generalizability. Therefore, one needs to make informed choices about the measures and procedures to serve the purposes, needs, and the context best (Pintrich et al., 2000).

## **5. Research on Metacognition Assessment**

In this part, ten research studies whose focus is assessing metacognition in the domain of reading will be presented. To understand how metacognition theory and previous research on metacognition impact current assessment practices, these studies will be analysed for their definition of metacognition, assessment measures and procedures, and their limitations, if stated at all. Also, selected studies will be presented chronologically to recognize whether there is an emerging pattern in the assessment of metacognition while its literature keeps increasing.

Kolić-Vehovec and Bajšanski (2006) aimed to explore students' developmental differences (5<sup>th</sup> to 8<sup>th</sup> grade) in comprehension monitoring and perceived use of reading strategies. For this purpose, they used error correction and text sensitivity tasks from Metacomprehension test. Although it is difficult to separate monitoring from regulation, their study was built on the argument that comprehension monitoring is important for the regulation of reading and regulation is manifested in a way how readers plan, monitor, evaluate, and use available information while they are building comprehension. Besides, because "the ability to monitor their [readers'] comprehension is not enough guarantee that children actually use reading strategies" (p.441), a self-report measure of reading strategies use was also adopted. While the results revealed significant grade level differences for text comprehension and cloze task performances, there were no statistically significant differences for error detection and text sensitivity among grade levels. Besides, comprehension monitoring was found to be significantly correlated to reading comprehension. However, perceived use of reading strategies was correlated to reading comprehension only in eighth grade.

Desoete (2008) also assessed third-graders' metacognitive skillfulness. For this purpose, she investigated four skills; prediction, planning, monitoring, and evaluation and calibration by using the Prospective Assessment of Children (PAC), Retrospective Assessment of Children (RAC), and teacher ratings as off-line ratings, and think-aloud protocol. Moreover, EPA 2000 was used as a combined (prospective and retrospective) form of assessment. The results confirmed teacher

ratings on predictions skills positively correlate with the combined assessment measure, but not with the child questionnaire. Teacher ratings of evaluation skills also correlated with the concurrent and combined assessment techniques. Besides, overall teacher ratings correlated with prospective child measure. Children's prospective and retrospective questionnaire results, which was not much influenced by students' actual performance, were not different and showed some evidence for convergent validity. The evaluation skill was found to be relatively independent in prospective child ratings and think-aloud. The author also highlighted "high intercorrelations between prediction, planning, monitoring, and evaluation skills rated by the teachers and between the prediction and evaluation skills assessed by EPA2000" (p. 204). Think aloud protocols, on the other hand, showed some evidence for the interaction of monitoring, planning, and prediction skills. Although the skills are generally related, the author recommended assessing skills separately.

Aiming to investigate Turkish high school students' metacognition and its relation to achievement goals, Sungur and Senler (2009) examined students' metacognition by its preliminary components. For this purpose, the study utilized the Metacognitive Awareness Inventory (MAI), the Achievement Goal Questionnaire (AGQ), the Competence Expectancy Scale, and the Challenge and Threat Construals. After running a confirmatory factor analysis, the authors pointed out that participants had "reasonable knowledge about themselves as learners, about strategies, and when and how to use these strategies. They also appeared to regulate their cognition at high levels" (p.52). It was also stated that all types of goal orientation and knowledge and regulation of cognition were positively correlated at each level.

Turan, Demirel, and Sayek (2009) argued that metacognitive awareness and self-regulated learning skills are important especially in the field of medicine because of the rapid change in knowledge. Conducting their study at four different medical schools implementing different curriculum, the authors used self-regulated learning perception scale (SRLPS) and metacognitive awareness inventory (MAI) to collect data from 862 students. They found a statistically significant difference among medical school curricular models. MAI and SRLSP scores of the students who study a problem-based learning (PBL) curriculum were higher than discipline- and system- based curricular models.

Zhang (2009), acknowledging the importance of reading in a second language, pointed out that non-native readers can apply their native language knowledge of reading processes and strategies to second and/or foreign language contexts. For effective strategy instruction, the study aimed to assess students' metacognitive awareness and reading strategy use and examine whether there are any differences in strategy choice among different proficiency levels. For these purposes, the author used SORS. The analysis revealed that the participants use reading strategies at a high-frequency level; they showed a moderate to high usage with problem solving strategies as their primary choice, followed by global strategies and support strategies. However, high-, intermediate-, and low-proficiency students were different in their strategy choice; "their pattern of strategy use is closely related to their overall EFL achievement" (p. 48).

Onovughe and Hannah (2011) also examined secondary school students' awareness and utilization of metacognitive strategies to comprehend academic materials. To obtain data from a group of 120 students, the authors used a questionnaire called "Students' Awareness and Application of some strategies to Reading and Comprehension" (p.344). While students' awareness of reading skills and strategies were rated on a 2-point scale, a set of 5 questions was used to identify students' purposes for reading. The authors concluded that secondary school



students in their study were aware of metacognitive strategies to a large extent as over 60% affirmation was obtained for each aspect of metacognitive strategies. Moreover, these participants applied metacognitive strategies in reading and comprehension to a large extent. The authors also highlighted a correlation between metacognitive awareness and utilization of metacognitive strategies.

Lee, Teo, and Bergin (2009) conducted their study specifically to understand “whether regulation of cognition and knowledge of cognition are related to everyday problem solving and whether students who perform better in the decision-making problem will better differentiate the various components of metacognition” (p. 89). The authors recruited 254 fifth grade students and they were given an everyday decision-making type of problem to solve; how to select a bike for purchase. To understand children’s decision-making, the authors adapted MAI for the problem-solving scenario. The findings revealed that 30.6% of the variance was accounted for regulation of and knowledge about cognition. And “at the higher level of decision-making, knowledge of cognition and regulation of cognition were differentiated in their use by the participants” (p. 97). The authors, therefore, claimed that students, who made poorer decisions in the given problem, could not discriminate among components of metacognition.

Akyol and Garrison (2011) examined how students demonstrate their metacognitive knowledge and skills in an online learning context. Coding 16 undergraduate students’ responses for knowledge about cognition, monitoring, and regulation of cognition, the authors chose 3 weeks (1<sup>st</sup>, 5<sup>th</sup>, and 9<sup>th</sup>) of online discussions to assess students’ metacognition. Observing possible changes in metacognition over time, the authors stated that while knowledge of cognition decreased in time, monitoring and regulation of cognition was noted to increase over time.

The study carried out by Saraç and Karakelle (2012) investigated the interrelation between different on-line and off-line measures for assessing metacognition. Working with 47 fifth grade elementary students, the authors utilized teacher rating scale, self-report questionnaire (Jr. MAI), think aloud protocols, and accuracy ratings (JOL) of text comprehension. The results showed some evidence for the correlation between two off-line measures (positive) and online measures (negative). However, there was no significant correlation between off-line and on-line measures.

Arguing that metacognitive skills directly shape learning behaviour and consequently impact learning outcomes, Veenman, Bavelaar, De Wolf, and Van Haaren (2014) conducted a study to assess metacognitive skills. As they argued that metacognitive skills can be assessed by on-line measures, students’ log-files of computerized tasks were used as data sources. Still, because log-files cannot reflect their metacognitive consideration for the specific enactments, log-file analysis was validated against other on-line methods. 52 students performed a computerized inductive learning task and then they were asked to complete a performance post-tests. The results revealed high convergent validity between log-file indicators and human judgements of learner activities.

## **6. Critical Summary**

This analysis of ten recent studies confirmed that knowledge about and regulation of cognition was assessed simultaneously in most cases as metacognition theory presents them. In this review, eight studies exclusively used off-line measures to assess metacognition (see Table 1). By using questionnaires, these eight studies assessed metacognition although questionnaires have been criticized especially for not appropriately assessing metacognitive skills. While two studies

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used both online and offline measures, only one study used solely online measures to assess metacognition. Also, only two studies focused solely on regulation of cognition rather than integrating it with knowledge about cognition. One of these studies assessed regulation of cognition through online measures and the other utilized both online and offline measures.

While research has used different measures and procedures to assess metacognition, in this review, a total of eight studies used different off-line measures like MAI, MARSJ, Jr. MAI, and SORS to assess knowledge about cognition. Only one study used an on-line measure of assessing knowledge about cognition. In that study, metacognitive behaviours were recorded and inferences regarding participants' knowledge about cognition were made by the researchers. Regulation of cognition was assessed in all studies. In addition to aforementioned measures, different self-report measures and on-line measures were used to assess regulation of cognition. However, only five studies assessed regulation of cognition by on-line measures like error correction and text sensitivity, think-aloud, observation of metacognitive behaviours, and analysis of computerized tasks' log-files. Besides, despite not mentioned in the literature, two of the studies used teacher-ratings to validate students' metacognition.

Few studies declared limitations that stem from their measurement choices. Although previous studies and pioneers in the field explicitly pointed out the limitations of recent measurement approaches, most of the researchers in this review were concerned about sample size, participant characteristics, and/or contexts that they collected their data from, if they ever mentioned limitations. Considering the generalizability of their findings and replicating similar research, one needs to be cautious of and alert against the potential flaws of the measurement, as well.

Lastly, the chronological analysis of these studies enabled to detect an emerging pattern in assessing metacognition. The latest studies in this review included specific tasks to assess metacognition rather than assessing it as a rigid construct. The earlier studies tended to use domain-general off-line measures to assess metacognition. The latest studies, on the contrary, included more specific real-life tasks for which participants need to employ different cognitive skills. While participants were engaged in task completion, their metacognition was assessed through on-line measures. Instead of generalizing one's metacognitive capability, such assessment procedures shed light on metacognitive processes and capabilities at the moment.

**Table 1.** Metacognition assessment pattern

<u>Components</u>	<u>Type</u>	<u>Off-line Assessment</u>	<u>On-line Assessment</u>	<u>Extras</u>	<u>Total</u>
<i>Knowledge of Cognition</i>	Declarative	✓ MAI	✓ Metacognitive behaviours		8
	Procedural	(Metacognitive Awareness Inventory)			
	Conditional	✓ MARSII			
		(Metacognitive Awareness of Reading Strategies Inventory)			
<i>Regulation of Cognition</i>	Predication	✓ PAC and RAC	✓ Error correction and text sensitivity	Teacher-ratings	10
		Planning			
	Monitoring				
	Regulation	✓ MAI			
	Evaluation and Calibration	✓ Jr. MAI			
		✓ MARSII			
		✓ SORS			
	✓ JOL	✓ Decision-making behaviours			
	(Judgment of Learning)	✓ Log-files of computerized tasks			

*Note.* Based on 10 studies assessing metacognition (published after 2006).

## 7. Discussion and Conclusion

Metacognition, a profound predictor of learning (Wang, Haertel, & Walberg, 1990), is composed of interacting features of knowledge about cognition and regulation of cognition (Schraw & Dennison, 1994). To assess metacognition, two approaches have been used. Through off-line methods, knowledge about strategies and estimated performance can be measured either before or after tasks. However, it cannot guarantee or estimate that individuals have strategies at their disposal or use them to regulate their learning behaviour (Veenman et al., 2006). Despite this fact, this review study confirmed that research unanimously used questionnaires to assess knowledge about and regulation of cognition. When people are given certain options to choose among, they are not really asked to manifest their knowledge, but they are asked to pick an appropriate option. Still more importantly, through questionnaires a researcher may not discriminate whether metacognitive knowledge is correct or complete or whether one can appreciate the usefulness of such knowledge in a situation. Moreover, interpretations of such assessment practices might be misleading when one might be inclined to generalize the assessment results, obtained by for example MAI, to any learning and/or performance situations. Nevertheless, I do not propose eliminating questionnaires to assess metacognition, but I propose integrating different data sources for verification.

Moreover, while assessing metacognition, one needs to recognize that interpretations are based on specific cases. Generalizing individuals' metacognitive adequacy to any other similar domains, therefore, might be inappropriate. Future research assessing individuals' metacognition can benefit from different domain tasks and cross-compare metacognitive engagement or behaviours to develop a holistic understanding of metacognitive adequacy. For example, to assess monitoring, instead of just asking students to detect errors in a reading paragraph, they may also be asked to reflect their understanding of a math problem, which has for example, logical inconsistencies. Then, individuals' metacognition in different domains can be analysed and compared.

Moreover while assessing metacognition, it is important to recognize different factors might impact metacognitive engagement and it is possible to confound these to students' adequacy. For example, when individuals are graded for their performances, as a partial fulfilment of their degrees, achievement motivation can interfere with the interpretations. On the other hand, individuals might not be interested in the task that they are provided and therefore, they may not be motivated for task completion. Without acknowledging characteristics and potential impacts of tasks and without recognizing individuals' volitional control (Pressley & Afflerbach, 1995), metacognitive assessment interpretations might be biased or incomplete. Future research on metacognitive assessment, therefore, needs to consider what drives or stops individuals from engaging in metacognitive processes and actions.

Finally, before assessing metacognition, it is very crucial to state the purpose of the assessment explicitly. While "research" and theory development can be valid reasons for academia, there should be some practical implications for teachers and students. As Lai (2011) stated, metacognition is not assessed regularly and traditionally at schools. Its instruction, therefore, might likely be ignored despite its beneficiary merits for achievement unless instructional and assessment practices are intertwined. While metacognition assessment research is carried out, it is important to state how metacognition assessment can benefit its instruction. In relation, as mentioned beforehand, two of the studies used teacher-ratings to validate individuals' self-reports of metacognition. Although metacognitive instruction has not been given a voice in these studies and teachers' awareness of metacognition and skills to

teach for metacognition has not been assessed, teachers' ratings were used to validate students' metacognition. Similar studies adopting teacher- ratings need to examine whether and how teachers interpret and rate students' metacognition especially in case they might not be metacognitive or they might not teach for metacognition, at all. In such cases, teachers, in fact, might know what and how to assess exactly and validly. Therefore, future research had better relate metacognition instruction and diagnostic assessment practices to empower not only students' metacognition but also teachers' understanding and practices of metacognition instruction and assessment.

## 8. References

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