University of South Australia

Measuring Metacognition in Children and Adolescents

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Executive Summary

The Fraser Mustard Centre brings together leading Australian child development researchers and innovative government policy makers and planners to improve the development, education, health and wellbeing of young Australians. The Centre is a unique approach to research translation between the University of South Australia and the Department for Education. One of the aims of the Centre is to build capacity amongst public sector staff and academic researchers to design, undertake and use research to improve the environments in which children live and the service systems which support families. Consistent with this aim, this Rapid Review is part of a series of reviews aimed at informing policy makers with the latest scientific evidence. These reviews are undertaken within a short time frame to be highly responsive to the Department's needs.

Recently the Department for Education released their new strategy for public education in South Australia under the themes of learning and thriving. The strategy states that the public education system aims to work in partnership with families and communities to nurture, develop and empower all South Australian children and young people with the knowledge, skills and capabilities they need to become fulfilled individuals, active, compassionate citizens and lifelong learners. Four areas of impact are defined: wellbeing, equity and excellence, learner agency and effective learners. As with any good strategy, each of the aims of impact are to be measured over time to evaluate progress. Within the effective learners impact area, metacognition is a named domain, however it is acknowledged that a measurement system to assess this across schools is yet to be developed in South Australia.

This Rapid Review aims to directly support the Department by providing a comprehensive overview of the current instruments available to measure metacognition. In doing so, we precis the literature for each instrument to provide details on the aspects of metacognition measured, details on the practicalities, and any evidenced reliability and validity. Our search of the literature has been refined to OECD member countries over the past 20 years. Specifically, we provide the relevant details necessary for the Department to consider potential instruments for assessing metacognition across different age groups within primary and secondary educational contexts.

Metacognition is a term that is used by many, however often with different meaning. Traditionally, metacognition has been considered to encompass both an understanding of cognitive processes and the capacity to regulate these processes effectively. More recently, studies form their understanding and measurement methodologies of metacognition from a focus on (1) metacognitive knowledge, and (2) metacognitive skills and experiences. Metacognitive knowledge can be simply described as knowing what to do, when, why and how. Crucially the scientific literature indicates that this knowledge can be taught. The student is then able to apply this knowledge and their skills and experiences can be measured and observed. Metacognitive research instruments explore a student's ability to monitor and control, whereby control is understood as higher order cognitive process strategies in relation to task demands and the feedback received from the monitoring processes.

We present within this report, neither a comprehensive systematic review or a simple rapid review, but something in between. To reconcile the trade-off between rigour and speed while maintaining the integrity of the search and screening processes, our research team adopted Moher et al.'s Moher et al. (2009) 'Preferred Reporting Items for Systematic Reviews and Meta-Analyses' (Moher et al.) Statement. PRISMA provides a standardised guideline for reporting systematic reviews and meta-analyses. It emphasises transparent and comprehensive reporting of key elements such as study selection, data extraction and study quality assessment, thereby enhancing the clarity and reliability of reviewed publications (Moher et al., 2009). Further, we build upon Gascoine et al.'s (2017) systematic review of instruments that measure metacognition published in 2016, however, it is important to note that our review has applied slightly different criteria (i.e., limited to OECD countries, quantitative instruments and papers published in the last 20 years).

Our search covered the most common databases utilised in the field of education, social and health sciences, including A+ Education, Cochrane Library, ERIC, ProQuest Central, PubMed, ScienceDirect, Scopus and we also included Google to capture any grey literature. Our initial search revealed 1028 unique papers. Of those 806 were removed as upon reading the abstract they did not meet criteria. A further 16 records were actually unavailable leaving 206 to fully appraise (i.e., the papers were read in entirety). From those 206 papers, 52 instruments were then fully considered within this report and the results presented. We provide data extraction tables that provide a precis of each instrument (these are appended) and summarise these into three main tables within the results section.

Overall, we find that quantifying metacognition presents complexities owing to its implicit character and a multitude of unresolved questions in educational research, including its domain generality and the interplay among its essential components. As such, the instruments reported here are quite varied in approach, administration and content. The utility of the different instruments will depend on the aims of sue. For example, to undertake population monitoring to inform policy and systems a task based instrument that involves video and coding of the observations will not be practical or reasonable. However, for small studies, or for teachers wanting to understand deeply a student's capabilities then this may be considered reasonable. For our recommendations we considered the practicalities associated with assessing metacognition in students at scale.

After considering the full 52 instruments we recommend the following five as they exhibit the strongest evidence for reliability, validity, practicality, and comprehensive data collection. These five also represent a wide range of age groups and metacognitive foci.

- The first is the Children's Perceived Use of SRL Inventory (CP-SRLI) which is a 75 item self-report questionnaire for 10–12-year-olds on metacognitive knowledge and control.
- The second instrument we recommend is the Junior Metacognitive Awareness Inventory (Jnr MAI) which is an adaptation of the Metacognitive Awareness Inventory (MAI) using an 18 item self-report questionnaire with 5-point Likert scale responses. The instrument is commonly used with 7–15-year-old students and measures both metacognitive knowledge and aspects of metacognitive control.
- The third instrument worth considering is the Metacognitive Awareness of Reading Strategies Inventory (MARSI) which is a domain specific 30 item questionnaire exploring three factors of metacognitive knowledge and control in relation to reading - global reading strategies, problem solving and support reading strategies. This instrument is easily scalable and aimed at 11- to 18-year-olds, however it fails to represent either metacognitive monitoring or wider metacognitive knowledge.
- The fourth instrument of interest is the Metacognitive monitoring computerised self report task exploring mathematics and spelling. This instrument is valid for students aged 7-9, whereby they report their judgements of accuracy after completing each answer of a mathematics and spelling test. Scoring is automatic and we include it here as it explores the area of metacognitive monitoring which is not covered by many of the other tools. Further the instrument is part of the OSF run by the Centre for Open Science and therefore free access to the software may be possible.
- The last instrument we considered worth recommending is the Children's Independent Learning Development (CHILD) checklist. Although this instrument is more burdensome to administer and has limited published validity it seems to be the best available for preschool aged children (3-5 years). The process requires video analysis using 22 criteria on metacognitive control, encompassing both verbal and non-verbal behaviours.

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About the authors

Dr Lisa Smith is an academic research assistant within Education Futures at the University of South Australia and a practicing secondary school teacher for the Department for Education. In 2021 she completed her doctoral thesis, titled '*Class, disaffection and exploring agonistic freedoms to be otherwise*'. This research explored relational pedagogies, equitable schooling practices and school-based opportunities which enable and support disaffected students to reconnect with mainstream education. Through her research role, Lisa has been developing expertise in oracy education, school leadership practice, critical policy analysis and rapid review processes.

Dr Sam Fowler is a lecturer and researcher at in Education Futures, specialising in professional development to transform in-service teachers' pedagogical reasoning. As part of the Centre for Change and Complexity in Learning (C3L) research group, he employs mixed-method approaches to investigate how teachers filter and apply professional knowledge. Additional research interests encompass Self-Regulated Learning, the application of AI within R-12 education and spatial reasoning.

Dr Florence Gabriel is an Enterprise Fellow in Education Futures and a Senior Research Fellow at the Centre for Change and Complexity in Learning (C3L) at the University of South Australia. She completed her PhD in educational neuroscience and psychology at the Université Libre de Bruxelles and the University of Cambridge. Before joining UniSA, she was a policy analyst with the OECD Directorate for Education and Skills. Her research focuses on the cognitive, metacognitive, motivational and affective factors that influence students' learning and academic achievement. She is particularly interested in self-regulated learning, mathematics anxiety and digital learning.

Professor Sally Brinkman's research aims to improve the healthy development and early learning of young children, with a focus on those living in highly disadvantaged communities. Her research is conducted across Australia, as well as countries in Asia, the Pacific, Latin America and the Emirates. She works in close partnership with international governments and donor organisations, such as the World Bank, UNICEF, and UNESCO. Sally regularly advises government and sits on numerous Expert Advisory Groups informing policy and practice. With over 200 publications, including high impact journals such as The Lancet, and her track record in achieving highly translatable research, she is well recognised nationally and internationally in both academic and policy environments.

Introduction

Metacognition is identified by many studies as being integral to effective learning and has consequently received much interest from Australian education systems (Quigley et al., 2019; Smith-Ferguson, 2020). Highly correlated with other valued thinking skills such as critical thinking (Akcaoğlu et al., 2023; Ku & Ho, 2010; Magno, 2010), metacognition has been proven to be malleable to training and particularly important to a students' overall academic development (de Boer et al., 2018; Donker et al., 2014) and the self-regulation of student learning (Efklides, 2011; Rutherford et al., 2018; Winne, 2022). This report amalgamates insights on metacognition from contemporary academic sources and identifies the tools utilised for its precise quantification. In this process, it establishes a foundation for subsequent research focused on the identification of suitable metacognitive interventions.

After an initial definition of metacognition is established, and the process of the review is described, the report describes and analyses many of the most commonly used research instruments. Recommendations are subsequently provided for the use or development of future tools.

Defining metacognition

Metacognition, like many scholarly concepts, has garnered a variety of definitions, each subtly differing in their focus. This has rendered a key aspect of learning (de Boer et al., 2018) somewhat elusive, making it challenging to clearly conceptualise (Marulis et al., 2016; Muijs & Bokhove, 2020) and subsequently integrate into educational systems (Perry et al., 2019). This is most evident in the case of self-regulation which is a term often used interchangeably with metacognition. Self-regulation however is a much broader concept, comprising elements of motivation and behaviour as explored in significant papers on self-regulated learning by Efklides (2006) and Boekaerts (1999). Figure 1 delineates the interconnections among these often-confused terms, illustrating that self-regulated learning is a more expansive version of self-regulation that is specifically directed towards academic goals and both are underpinned by metacognitive knowledge and processes.

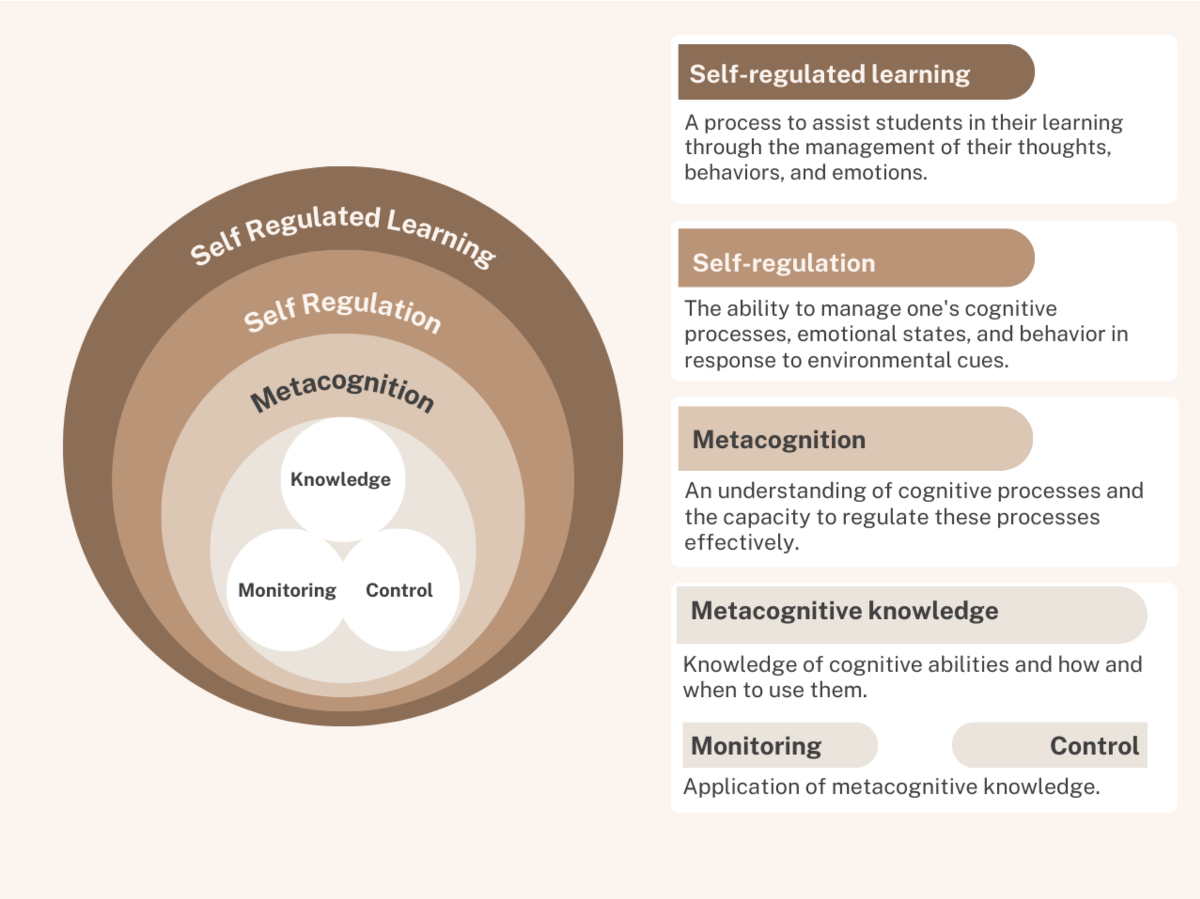

Figure 1: Positioning Metacognition in relation to Self-Regulation and Self-Regulated Learning

The genesis of the term 'metacognition' is often attributed to the seminal works of Flavell (1976) and Brown (1977). Their pioneering research portrayed metacognition as encompassing both an understanding of cognitive processes and the capacity to regulate these processes effectively. A clear difficulty arising from this generalist perspective is determining when mental activity is cognitive or metacognitive as both can play a part in problem solving and learning. As Ku and Ho (2010) posit however, intention determines the nature of the activity. Cognitive activities facilitate engagement with new knowledge, while metacognition is a higher order agent regulating the cognitive performance (Veenman et al., 2006).

A considerable number of studies form their understanding and measurement methodologies of metacognition from focus on the knowledge, skills and experiences described by Flavell and Brown. Hence, it is crucial to dissect and precisely define each of these elements.

Metacognitive knowledge

Flavell (1979) described metacognitive knowledge as the knowledge of one's cognitive abilities (declarative), the knowledge on how to do particular cognitive strategies (procedural) and when those strategies would be most effective (conditional). Veenman et al. (2006) neatly summarises this in their WWW&H rule (what to do, when, why and how). To a certain degree metacognitive knowledge can be perceived as domain specific (Neuenhaus et al., 2011), as a student may identify an array of strategies they use for mathematics but struggle to implement cognitive strategies when reading. However, many researchers have identified that metacognitive knowledge is teachable and has high transference across disciplines (see for example Bellon et al., 2020b; Carpenter et al., 2019; Schraw et al., 2001; Schuster et al., 2020). Commonly data relating to this element of metacognition is sought from questionnaires such as the MSLQ and the updated Wellbeing and Engagement Collection (WEC) undertaken by the Department.

Metacognitive skills and experiences

In addition to understanding the mental processes encompassed by metacognitive knowledge, it is essential to acknowledge the crucial role of their application. Nelson and Naren's (1990) theory of metamemory offers a simple conceptualisation of the processes key to the functional aspects of metacognition. This theory posited that cognitive processes are split into two interrelated levels – the object-level of the task and the meta-level of the representation of the task. When information is flowing from the object-level to the meta-level then one is engaging monitoring metacognitive processes. When information is directed from the meta-level to the object-level, then control metacognitive processes are engaged. Monitoring and control rarely happen independently but they are often explored in different ways through metacognitive research instrument.

Monitoring

For effective application of metacognitive knowledge in task scenarios, students must initially forecast the task's demands and recognise the specific strategies they have at their disposal for its successful completion. Sometimes called metacomprehension (Maki & Berry, 1984), the accuracy of these judgements can be crucial to achievement of learning goals as studies have highlighted that those who are overconfident, and therefore have a distorted perception of their own performance, often underachieve (Dunlosky & Rawson, 2012; Thiede et al., 2003).

After completing the task, it is equally vital for students to accurately evaluate their performance. This self-assessment informs future strategy choices, allowing them to improve based on their previous mistakes (Bellon et al., 2020b). Numerous quantitative instruments for assessing metacognitive monitoring employ straightforward indicators, such as initial evaluations of novel tasks prior to students tackling them, followed by post-task assessments of their performance (see for example Bellon et al., 2020b; Bryce & Whitebread, 2012; Roebers et al., 2009).

Control

The conceptual boundaries between metacognition and self-regulation are rarely clear as they share a focus on self-awareness and control (Kaplan, 2008). However, control in the context of metacognition describes the way higher order processes augment cognitive strategies in relation to task demands and the feedback received from the monitoring processes (Terneusen et al., 2023). When an individual's metacognitive monitoring suggest that their strategies will not achieve their aims, metacognitive control instigates changes (Nelson & Narens, 1990). Often these processes are unconscious, but it is suggested that this important connection between the monitoring of performance and the enacting of metacognitive knowledge can be trained (Lyons & Zelazo, 2011; Metcalfe, 2009). Some common instruments used to measure this aspect of metacognition include the 'Junior Metacognitive Awareness inventory' (Sperling et al., 2002), the 'Children's Independent Learning Development' (CHILD) checklist (Whitebread et al., 2009) and various think aloud protocols (see for example Deekens et al., 2018a).

The domain specificity of metacognition

A contentious issue in the study of metacognition is the amount of transfer between domains in metacognition. Whilst behavioural studies (e.g. de Gardelle & Mamassian, 2014) and neurological research (e.g. Morales et al., 2018; Su et al., 2022) suggest that metacognitive skills in adults often have a domain-general nature, the extent of this generality remains a topic of debate. This becomes even more complex in child studies due to methodologies that often focus on specific academic disciplines or behaviours, with limited longitudinal examination of transferability (Geurten et al., 2018). Further research is warranted in this area, but is should be noted that concepts of domain specificity or generality have a direct impact on the perceived usefulness of the research instruments explored in this analysis.

Research question

Metacognition has been the subject of numerous studies, each presenting unique perspectives and incorporating different elements of metacognitive knowledge and processes within varying contexts. These studies have employed a range of metrics to gauge the effect of metacognitive interventions and to explore the nature of metacognition. This review study aims to identify high-quality, evidence-based quantitative tools from existing literature. Accordingly, the guiding research question for this study is: '*What are the potential instruments for assessing metacognition across different age groups within primary and secondary educational contexts of OECD member countries over the past 20 years?*'

Method

Search Process

Systematic reviews employ a clearly formulated research question to conduct comprehensive searches and appraise the quality of and summarise all available evidence. This process adheres to transparent and reproducible methods, contributing to its prominent position within evidence hierarchy pyramids (Higgins et al., 2019). Due to the quality and rigour of systematic reviews, they frequently inform large-scale decision-making including policy design (Scott et al., 2023). However, as documented by Scott et al. (2023), systematic reviews can be time-consuming with a median timeframe of 66 weeks from protocol registration to publication (p. 111). This poses a significant challenge for research teams in terms of time commitment and also hinders decision makers who require more expeditious access to evidence. One proposed solution is to perform a 'rapid review'.

Rapid reviews generally involve a streamlined process to expedite the process of gathering and synthesising existing evidence, providing more timely information to inform decision-making or to address urgent policy needs. Unlike traditional systematic reviews which often involve comprehensive searches, quality assessments, and extensive data analysis, rapid reviews streamline these steps to achieve faster results, but the quality can be compromised as studies are not appraised in terms of their reliability or validity. To reconcile the trade-off between rigour and speed while maintaining the integrity of the search and screening processes, our research team adopted Moher et al.'s (2009) Additionally we followed the 'Preferred Reporting Items for Systematic Reviews and Meta-Analyses' (Moher et al.) Statement for guidance. PRISMA provides a standardised guideline for reporting systematic reviews and meta-analyses. It emphasises transparent and comprehensive reporting of key elements such as study selection, data extraction and study quality assessment, thereby enhancing the clarity and reliability of reviewed publications (Moher et al., 2009).

Findings derived from this review build upon Gascoine et al.'s (2017) systematic review of instruments that measure metacognition published in 2016, however, it is important to note that our review has applied slightly different criteria (i.e. limited to OECD countries, quantitative instruments and papers published in the last 20 years).

Inclusion and exclusion criteria

The central question, in conjunction with clear research parameters set by South Australia's Department for Education (DfE), were integral to guiding and refining the search methodology. To restrict results to a manageable volume of records for screening, a pilot search was initially conducted, experimenting with various keywords and search strings across several databases, including the Education Resources Information Centre (ERIC)(Anderson & Haney, 2021), ProQuest and Scopus. Subsequently, the refined search string was applied to a total of seven databases: A+ Education, Cochrane Library, ERIC, ProQuest, Science Direct, PubMed and Scopus. Additionally, grey literature was acquired by utilising the search string in the Google search engine to capture relevant government-based reports. For a comprehensive overview of the search string and applied inclusion and exclusion criteria, see Table 4 in the Appendix.

Clear inclusion criteria for the search methodology were established prior to conducting the database search. These criteria encompassed the following parameters:

- Records published on or after 1 January 2003;
- Only quantitative records were considered;
- The records and instruments were required to be available in English;
- The study had to be conducted in a member country of the Organisation for Economic Cooperation and Development (OECD);
- The instruments needed to be suitable for use with students in a primary and/or secondary school setting.

Furthermore, the exclusion criteria naturally followed from the aforementioned inclusion criteria. For example, qualitative records were automatically excluded since only quantitative records were being considered. Additionally, one specific exclusion criterion was explicitly set for this review: measures, tools or instruments designed specifically for students with identified learning difficulties and/or disabilities. It is anticipated that instruments developed for measuring or assessing students with learning difficulties and/or disabilities may be used to inform the focus of an additional review.

A full inventory of the inclusion and exclusion criteria used in the screening process can be found in Table 4.

Screening of selected studies

Despite its length, the screening process was rigorous to preserve the integrity of the review. Table 5 in the Appendix displays the precise figures of inclusions and exclusions for each of the seven databases at every stage of the screening process.

Following the removal of duplicates from the original list of records, author one performed the first phase of the screening process. This phase involved examining the title and abstract of each record to ensure alignment with the review's topic (i.e., use of an instrument for the measurement or assessment of metacognition). Additionally, author one verified that each study was conducted in an OECD country with school-aged participants (ages 5-18). A list of all papers excluded and the reason for their exclusion can be found in Appendix 2.

Prior to the subsequent screening phase, a measure of inter-coder reliability was conducted, involving authors one, two and three, triple-screening, coding and completing a data extraction. This process spanned three rounds, each comprising five records, resulting in a total of 15 records assessed. The three authors convened after each round to check for overlap, and this process was iterated until an agreement level of approximately 80% was reached.

Upon completion of the inter-coder reliability assessment, records were systematically categorised based on the specific instrument outlined in the abstract, for instance, Junior Metacognitive Awareness Inventory (JrMAI), Metacognitive Awareness of Reading Strategies Inventory (MARSI), Motivated Strategies for Learning Questionnaire (MSLQ), among others. A separate set of records was allocated to a folder labelled 'unsure'. Authors one and two undertook further full text screening of these records since the abstracts lacked clarity regarding the instrument or methodology employed.

A total of 48 instrument folders were generated, and then distributed amongst the first three authors to facilitate the second and final screening phase. Each author undertook a comprehensive full text screening for their respective set of records, with a particular focus on the methodology section of each record, given its pivotal role in data extraction. The coding process, following the framework employed by Gascoine et al. (2017, p. 11), encompassed several variables to ascertain whether records should be included or excluded. These variables included the availability of complete reference details, a clear definition of metacognition, sample characteristics pertaining to age group and educational setting, as well as methodological information to assess replicability in primary and/or school settings.

The screening process adopted in this review was extensive and rigorous, aiming to ensure the inclusion of relevant and accurate studies on metacognition measurement instruments in OECD countries. The use of inter-coder reliability checks and specific coding criteria allowed for a robust selection of records for further analysis. This approach enhances the credibility and reliability of the review's findings and contributes to the overall integrity of the research in the field of metacognitive assessment.

Results

First, we provide a table of the instruments that met the original inclusion criteria. Here we provide the original reference pertaining to that instrument, a brief description including the method of administration, the age for which it is appropriate, and the aspect of metacognition measured.

Second, we provide the same list of instruments, but present details on how the concept measured is being described by the authors, and the list the aspects of reliability and validity for which the instrument has been tested for. Please note that we do not indicate if the level of reliability or validity meets any base criteria or not, just that the aspect has been assessed. Some details are provided in the data extraction tables within Appendix 0.

Third we provide again the same list of instruments and here we provide our recommendation level and provide some details on our view regarding the practicality considerations for any use i.e. if we consider it to be practical at scale or not.

Taken together these three tables provide a comprehensive precis of each of the instruments and should at least provide the Department a very solid evidence base for deeper consideration of the ones recommended.

Table 1: Instrument list: description, administration, aspect of metacognition measured and age appropriate for

Papers (original paper in bold)	**Name of the instrument**	**Description of the instrument**	**Instrument administration**	**Aspect of metacognition measured**	**Approximate age range in years**
Cirino et al. (2018) (2010); **Gioia et al. (2000);** Lemberger and Clemens (2012); Momoda et al. (2019); Rizzo et al. (2010)	Behaviour rating inventory of executive function (BRIEF)	86 question parent and teacher form using a 3-point scale (never, sometimes, often)	Parent and teacher report	Metacognitive control	5-18
Whitebread et al. (2009)	Children's Independent Learning Development (CHILD) checklist	Video of students working individually and in groups is coded using 22 statements from the literature.	Video observation of a task	Metacognitive control	3-5
Pezzica et al. (2016)	Children's Awareness of Attention Through Drawing	Students produce two drawings on A4 paper and assessed using a coding scheme.	Task based	Metacognitive knowledge	8-10
Baas et al. (2015); **Vandevelde et al. (2013)**	Children's Perceived Use of SRL Inventory (CP-SRLI)	75 item questionnaire	Self-report questionnaire	Metacognitive knowledge and monitoring	10-12
Moning and Roelle (2021)	Coding Scheme for Learning Protocols	Coding scheme to assess quantity and quality of metacognitive processes and measured with an 8-point rating scale ranging from 1 (very low quality) to 8 (very high quality)	Self-report	Metacognitive monitoring	13-16
Contreras et al. (2020)	Confidence Judgement Tasks	Students do a task and then participants are interviewed about how they did.	Observation of a task	Metacognitive monitoring	7
Destan et al. (2017a)	Confidence Judgement	Students learn Kanji on a tablet and provide confidence judgements on a 7-point scale ('very unsure' to 'very sure').	Performance base judgements	Metacognitive monitoring	6-8
Roebers et al. (2009); Roebers and Spiess (2017); Roebers et al. (2021)	Confidence Judgement	Multi-phase task in context of spelling	Task based	Metacognitive monitoring	7-8
Anderson and Haney (2021)	Creative Metacognitive Measure	Two open-ended questions used to evaluate a creative task which is marked by raters on a scale from 0 (incomplete response) to 2 (complete response).	Task based	Metacognitive knowledge and monitoring	12-13
Meyer et al. (2010)	Electronic portfolio tool	Web based software supporting and measuring metacognition within the phases of SRL. This led to a portfolio that was coded and triangulated with open ended question responses	Task based	Metacognitive knowledge and monitoring	9-12
Mevarech and Paz-Baruch (2022)	Metaprocess (MP) Questionnaire	A 14-item questionnaire used to assess students' metaprocesses. Scored on a 4-point Likert scale.	Questionnaire/self-report	Metacognitive knowledge and control	9-12

De Clercq et al. (2000)	Evaluation and Prediction Instrument (EPA2000)	Computerised instrument where children look at mathematical exercises without solving them to predict whether they would be successful using a 4-point colour rating scale.	Self-report	Metacognitive monitoring	8-9
Glogger, Schwonke, Holzapfel, et al. (2012)	Journaling	Students develop learning journals in mathematics classrooms and quality rated on a 6-point scale ranging from 1 (very low quality) to 6 (very high quality). Method replicated with biology students.	Teacher ratings	Metacognitive control	14-15
Acar (2019); Balta (2018); Beach et al. (2020); (Kirbulut, 2014); Kruit et al. (2018a); Kruit et al. (2018b); Lemberger and Clemens (2012); Nieto-Márquez et al. (2020); Acar (2022) Saraç and Karakelle (2012); Schwartz et al. (2004); **Sperling et al. (2002);** Sperling et al. (2012)	Junior Metacognitive Awareness Inventory (Jr MAI)	Developed from the MAI (Schraw & Dennison, 1994). Contains two versions, A and B. A is a 12-item questionnaire using three responses (never, sometimes, always); B is an 18 item questionnaire (same 12 as A with 6 additional) with 5-point Likert scale.	Self-report inventory	Metacognitive knowledge and control	7-15
Bednorz and Bruhn (2023)	Mathematics, School and Me	A 15 item self-report questionnaire exploring repetition, elaboration and controlling strategies. Responded to using a 4-point Likert scale.	Self-report questionnaire	Metacognitive knowledge	16-17
M. Settanni et al. (2012)	Metacognitive Applied to a Physical Activity Scale	Questioning derived from an Italian paper (untranslated). Tool has 10 questions, and the students complete it an hour after their 2-hour PE lesson.	Task-based and self-report	Metacognitive knowledge	11-15
Desoete et al. (2001); Özsoy (2011); Özsoy and Ataman (2009)	Metacognitive Attribution Assessment (MAA)	A 13-item attribution rating scale based on work of Carr and Jessup (1995). Children evaluate internal stable (e.g., ability), internal nonstable (e.g., effort), external stable (e.g., task characteristics) and external nonstable (e.g., luck) attributions as causes of hypothetical situations. The four alternatives (internal stable, internal nonstable, external stable, and external nonstable) are ranked on a 4-point scale according to perceived importance (pp. 437-438).	Test	Metacognitive knowledge, monitoring and control	8-9
Atmatzidou et al. (2018) Çini et al. (2023); Lee (2013); **Schraw and Dennison (1994);** Snyder et al. (2011); Van Velzen (2013); Sungur and Senler (2009); Umino and Dammeyer (2016); Zepeda et al. (2015)	Metacognitive Awareness Inventory (MAI)	A 52-item inventory used to measure metacognitive awareness. Classified into 8 subcomponents. Ratings made on a 100-point scale.	Self-report	Metacognitive knowledge and control	15-18
Davis et al. (2017); **Mokhtari and Reichard (2002);** NSW Department of Education (2020); Onde et al. (2022);	Metacognitive Awareness of Reading Strategies Inventory (MARSI)	A 30 item self-report questionnaire with three factors - global reading strategies, problem solving and support reading strategies.	Self-report questionnaire	Metacognitive knowledge and control	11-18

(Tamin & Büyükahiska, 2020)					
Vandergrift et al. (2006); Wallace (2022)	Metacognitive Awareness Listening Questionnaire	39 item questionnaire using a 6-point Likert scale (Strongly agree to strongly disagree) – provided in paper. This was administered after the class had been involved with an authentic listening activity	Questionnaire	Metacognitive knowledge and control	12-18
Anderson and Nashon (2007); Nielsen et al. (2009)	Metacognitive Baseline Questionnaire (MBQ)	A 53-item questionnaire developed for determining individual metacognitive profiles on each of the six dimensions (p. 302). The six dimensions measured include: awareness, control, evaluation, planning, monitoring and self-efficacy. The 53 items are distributed across the six dimensions on a 5-point Likert scale.	Self-report questionnaire	Metacognitive knowledge, monitoring and control	16-17
Neuenhaus et al. (2011)	Metacognitive Knowledge - general (MK-general)	Participants assessed different strategies for their efficacy in developing effective learning.	Self-report	Metacognitive knowledge	10-11
A. Efklides and S. P. Vlachopoulos (2012)	Metacognitive Knowledge in Mathematics Questionnaire	Self-report questionnaire exploring metacognitive knowledge of self (2 subscales – easiness/fluency and difficulty/lack of fluency), tasks (2 subscales – easy/low demand and difficult/high demand) and strategies (3 subscales – cognitive/metacognitive strategies, competence-enhancing strategies and avoidance strategies).	Self-report questionnaire	Metacognitive knowledge	12-15
Marulis et al. (2016); NSW Department of Education (2020)	Metacognitive Knowledge Interview (McKI)	Students completed challenging puzzles and then were interviewed on knowledge about people, tasks and strategies. Coding based on 0-2 (not at all metacognitive – appropriate metacognitive response).	Task-based and interview	Metacognitive knowledge	3-5
Neuenhaus et al. (2011)	Metacognitive Knowledge - mathematics (MK-mathematics)	Participants assessed different strategies for their efficacy in solving particular domain specific problems.	Self-report	Metacognitive knowledge	10-11
Neuenhaus et al. (2011)	Metacognitive Knowledge - reading (MK-reading)	Participants assessed different strategies for their efficacy in solving particular domain specific problems.	Self-report	Metacognitive knowledge	10-11
Haberkorn et al. (2014)	Metacognitive Knowledge Test	For each of the 15 tasks on metacognitive knowledge, a situation involving mental performance and three options were presented to the children. The test examiner read aloud the situations and the corresponding options and the children followed each approach by looking at the pictures in their test booklet. The examiner then asked the children which of the options presented they thought would be the best for performing a particular task. The children had to mark one out of the three options.	Test	Metacognitive knowledge	6-8
Bellon et al. (2020a)	Metacognitive Monitoring	Children report their judgements of accuracy after completing each answer of a mathematics and spelling test (correct, incorrect, did not know). This was done within a computer program. Scoring based on responses correlating to performance (2), non-correlation (0) or saying they did not know (1).	Self-report	Metacognitive monitoring	7-9
Alkin-Şahin (2015)	Metacognitive Orientation Learning Environment Scale-Science (MOLE-S)	MOLES-S includes 21 items aimed at eliciting how students perceive science classes in terms of their metacognitive orientation and what kinds of experiences they have regarding metacognition in science	Self-report	Metacognitive control	10-14

		classes. The items in the scale are scored ranging from "1-Never to 5-Always."			
Wagaba et al. (2016)	Metacognitive Strategies Questionnaire (MStQ)	Consists of 28 items in three scales – Cognitive Strategy use (CSu), Self-Regulation (SR) and Cognitive Self-consciousness (CSC)	Questionnaire	Metacognitive knowledge and control	14-15
Wagaba et al. (2016)	Metacognitive Support Questionnaire (MSpQ)	Consists of 25 items in five scales – Student-Student Discourse (SSD), Student-Teacher Discourse (STD), Student Voice (Robbers et al.), Metacognitive Demand (MD) and Teacher Encouragement and Support (TES).	Questionnaire	Metacognitive knowledge and control	14-15
Berger and Karabenick (2016)	Metacognitive Self Regulation (MSR)	Students completed the MSR; 15 participants with highest results and 15 with the lowest results were then interviewed. MSR items from the MSLQ but related to maths and set to the three Zimmerman phases. Self-report questionnaire of 13 items.	Self-report questionnaire and interview	Metacognitive knowledge	14-15
Desoete *et al.* (2001); Özsoy (2011); Özsoy and Ataman (2009)	Metacognitive Skills and Knowledge Assessment (MSA)	The MSA assesses, without time limit, two metacognitive components (knowledge and skills) including seven metacognitive parameters (declarative, procedural, and conditional knowledge, and prediction, planning, monitoring, and evaluation skills) (p. 438).	Written test	Metacognitive knowledge and control	8-9
Schmitt (1990); Davis et al. (2017)	Metacomprehension Strategy Index (Durai et al.)	A 25 item, 4 option, multiple choice questionnaire	Questionnaire: Teacher or student completed	Metacognitive monitoring	10-18
Theodosiou et al. (2008)	Metacognitive Processes in Physical Education Questionnaire (MPIPEQ)	Developed to measure students' metacognitive activity in physical education lessons	Self-report	Metacognitive knowledge	10-18
Alkin-Şahin (2015)	Metacognitive Orientation Learning Environment Scale-Science (MOLE-S)	MOLES-S is comprised of five dimensions: emotional support, distributed control, student-student discourse, student voice, and metacognitive demands.	Self-report	Metacognitive control	10-14
Ahmed et al. (2013); Alpaslan et al. (2016); Haelermans (2022); Jacobse and Harskamp (2012); Karadeniz et al. (2008); Kiran and Sungur (2012); Metallidou and Vlachou (2010);Ortega-Torres et al. (2020); **Pintrich and De Groot (1990)**; Sungur (2007); Veenman and van Cleef (2019); Wolters (2004)	Motivation Strategies for Learning Questionnaire (MSLQ)	Includes 56 items on student motivation, cognitive strategy use, metacognitive strategy use and management of effort (p. 34). 7-point Likert scale applied ranging from 1=not at all true of me to 7=very true of me in relation to their behaviour in either their science or English class.	Self-report questionnaire	Metacognitive knowledge	12-13
Liu et al. (2008)	Middle School Learning Strategies (MSLS)	Consists of 52 items with response categories including *hardly ever, sometimes, often,* and *almost always*. For the latter, the responses ranged from strongly disagree, disagree, agree, to strongly agree. All items were scored on a 4-point Likert scale	Self-report	Metacognitive knowledge	11-14

Van Velzen (2013))	Multiple Choice Questions	19 multiple-choice questions constructed (MKLP), 9 measuring cognitive knowledge, 3 for procedural knowledge, 5 for knowledge of task demands and five questions for metamemory	Questionnaire	Metacognitive knowledge	12-18
Neuenhaus et al. (2018); **OECD (2007);** Zhou et al. (2020)	PISA 2009	A number of reading scenarios (short vignettes) are presented to students. For each scenario, students are asked to evaluate the quality and usefulness of different reading and text comprehension strategies for reaching the intended goal	Self-report	Metacognitive knowledge and control	15
Cottini et al. (2021)	Ongoing Task (OT) performance	OT was divided into two blocks: one without PM task instructions and targets (single OT), and one with PM task instructions and targets (dual OT)	Self-report	Metacognitive monitoring	5-10
Cottini et al. (2021)	Prospective Memory task (PM)	PM assessed by means of a computerised 1-back WM picture classification task.	Self-report	Metacognitive monitoring	5-10
Amsterlaw (2006)	Reasoning/Not Reasoning Task	Participants receive nine scenarios (3 reasoning, 3 shortcut problem solving, 3 automatic action). There was a picture of a child's face. The participants were asked to respond to a set of questions. Responses were coded.	Test	Metacognitive knowledge	6-11
Kruit et al. (2018a)	Science Meta Test (SMT)	Consists of 13 items with a three-point scale (not, a little, a lot).	Test	Metacognitive knowledge, monitoring and control	10-12
Lenski et al. (2022)	Self-Evaluation	Self-evaluation on students' concept map skills was measured with five statements; "I read the text thoroughly," "I used all the concept stickers," "I paid attention to the direction of the arrows.", "I labelled all the arrows." and "I understood connections between concepts." Students rated their agreement on a three-stepped emoticon-based scale (joyful, indifferent, sad smiley).	Self-report	Metacognitive monitoring	13-14
van Velzen (2017)	Self-Induced Self-Reflective Thinking (SISRT)	Three open-ended SISRT questions used to enable participants to write down a response in their own words by stating what they know about SISRT. The three questions follow the process of reflection.	Self-report	Metacognitive knowledge	14-15
Sperling et al. (2012); Swanson (1990)	Swanson Metacognitive Questionnaire (MSQ)	Children individually presented with a questionnaire containing 17 items. Responses are tape-recorded. Coding criterion established for each item. Data from questionnaires scored according to five response categories ranked 1 to 5 according to metacognitive awareness. Probes were used to clarify confusing answers, e.g., "tell me more …"	Questionnaire	Metacognitive knowledge	9-11
Veenman, Kok and Blote (2005)	Systematic Operation (SO)	All participants instructed to 'think aloud' while individually solving six math problems.	Task-based and observation-based	Metacognitive control	12-13
Baer and Odic (2020)	Relative Approximate Number System (ANS) Metacognition Task	Conducted on a computer. Participants choose an item they feel most confident in answering. They are shown two screenshots of dot comparisons and they point to the one they are more certain about calculating whether there are more blue or yellow dots.	Test	Metacognitive monitoring	4-6
Deekens et al. (2018b)	Think Aloud Protocols	After completing a pre-test of the topic students think out loud as they write down information about the regulator movement. Trained researcher assistants coded these verbalisations.	Think aloud	Metacognitive control	16

Bryce and Whitebread (2012)	Train Track Task	Children's verbalisations and non-verbal behaviours coded for metacognitive strategy use whilst completing a task involving train tracks. Coding schemes for both metacognitive skills and perseverance and distraction are used.	Task-based and observation-based	Metacognitive monitoring and control	5-8
García et al. (2016)	Triple Task Procedure in Mathematics (TTPM)	Two mathematics problems are provided. Post performance judgements are collected related to how successful they were (yes/no).	Task-based and teacher rating	Metacognitive monitoring	10-13

Table 2: Instrument list: reliability and validity

		Reliability			Validity					
Name of the instrument	**How the concept being measured is described**	**Internal consistency**	**Test-retest**	**Inter-rater**	**Construct**	**Face**	**Utility within school settings/ Ecological**	**Concurrent criterion**	**Predictive criterion**	**Instrument Available**
Behaviour rating inventory of executive function (BRIEF)	Metacognitive control as executive function.		X		X		X			X
Children's Independent Learning Development (CHILD) checklist	Uses Flavell's (1979) and Brown's (1987) definitions of metacognition as consisting of knowledge, monitoring and control.	X	X							X
Children's Awareness of Attention Through Drawing	Metacognitive knowledge as related to mental functioning.					X				X
Children's Perceived Use of SRL Inventory (CP-SRLI)	Not explicit, but implies knowledge of oneself, tasks and strategies.	X			X		X			X
Coding Scheme for Learning Protocols	No explicit definition offered.			X						X
Confidence Judgement Tasks	Metacognition as reflection about own mental processes produced in a more or less conscious way.	X								
Confidence Judgement	Metacognitive monitoring as the ability to monitor and evaluate own performance.					X				X
Confidence Judgement	No explicit definition offered.						X			Confidence scale available, but cloze questions are not.

Creative Metacognitive Measure	Creative metacognition is the combination of creative self-awareness, strategy, and contextual understanding.	X		X	X					X
Electronic Portfolio tool (ePEARL)	Metacognition as awareness, knowledge and control of cognition.			X			X			X
Metaprocess (MP) Questionnaire	Metacognition as a broad umbrella of processes including planning, control, monitoring and evaluation.									X
Evaluation and Prediction Instrument (EPA2000)	Metacognition defined as a awareness of one's own cognitive functioning and the active monitoring of one's own cognitive processes.	X			X			X		X
Journalling	The regulation of cognitive strategies in task completion.			X						X
Junior Metacognitive Awareness Inventory (Jr MAI)	Uses Brown’s (1987) definition of metacognition as being knowledge of cognition and regulation of cognition.	X	X		X	X		X		X
Mathematics, School and Me	Metacognition defined as knowledge of how (procedural), when (conditional) and why (declarative) to use cognitive strategies.			X						
Metacognitive Applied to a Physical Activity Scale	Metacognition represents the awareness that individuals have of their own cognitive abilities (and limitations) and of their and others' mental functioning; such awareness is developed in relation to different areas of learning such as linguistic, mathematical, emotional-affective, and physical activity areas' (p. 68).				X	X				X
Metacognitive Attribution Assessment (MAA)	Refers to Flavell's (1976) definition describing metacognitive knowledge as the	X						X		X

	knowledge and deeper understanding of cognitive processes and products (p. 45).									
Metacognitive Awareness Inventory (MAI)	Metacognition defined as the ability to reflect upon, understand and control one's learning (p. 460).	X			X					X
Metacognitive Awareness of Reading Strategies Inventory (MARSI)	Monitoring and strategic cognitive choice in response to a task.	X			X					X
Metacognitive Awareness Listening Questionnaire (MALQ)	Based on Flavell's definition of knowledge of cognitive states and processes and how to control them.	X			X					X
Metacognitive Baseline Questionnaire (MBQ)	Metacognition described as active monitoring, conscious control, and regulation of learning processes	X				X				X
Metacognitive Knowledge - general (MK-general)	Metacognition as facilitation of effective learning strategy usage.				X					?
Metacognitive Knowledge in Mathematics Questionnaire (MKMQ)	Begins with Flavell’s (1976) definition but simplifies to knowledge of self, tasks and strategies.		X	X						X
Metacognitive Knowledge Interview (McKI)	Flavell’s (1976) definition of metacognition being the knowledge of people, tasks and strategies.		X			X				X
Metacognitive Knowledge - mathematics (MK-mathematics)	Metacognition as exploring conditional and relational metacognition within particular contexts.				X					
Metacognitive Knowledge - reading (MK-reading)	Metacognition as exploring conditional and relational metacognition within particular contexts.				X					Partial example provided
Metacognitive Knowledge Test	Conceptualise metacognitive knowledge as 'the declarative component besides				X					X

	children’s procedural activities in regulating and monitoring memory performance during a task' (p. 240)									
Metacognitive Monitoring	Procedural metacognition where one's self reflects on performance.			X					X	May be possible
Metacognitive Orientation Learning Environment Scale-Science (MOLE-S)	Refers to Flavell’s definition as well as Livingston’s (1997) ‘thinking about thinking’ definition (p. 242).				X					
Metacognitive Strategies Questionnaire (MStQ)	Metacognition as 'awareness of one’s thinking, active monitoring of cognitive processes, regulation of cognitive processes and application of heuristics to organise problem-solving' (p. 254).	X								X
Metacognitive Support Questionnaire (MSpQ)	Metacognition as 'awareness of one’s thinking, active monitoring of cognitive processes, regulation of cognitive processes and application of heuristics to organise problem-solving' (p. 254).	X								X
Metacognitive Self Regulation (MSR)	Zimmerman’s definition of forethought, monitoring and reflection.			X						
Metacognitive Skills and Knowledge Assessment (MSA)	Refers to Flavell's (1976) definition describing metacognitive knowledge as the knowledge and deeper understanding of cognitive processes and products (p. 45).	X						X		X
Metacomprehension Strategy Index (Durai et al.)	No explicit definition offered.	X				X		X		X
Metacognitive Processes in Physical Education Questionnaire (MPIPEQ)	Refers to Flavell's (1979) definition of metacognition to describe it as an 'individual’s ability to know and control his/her cognitions' (p. 353).	X								X

Metacognitive Orientation Learning Environment Scale-Science (MOLE-S)	Refers to Flavell's definition as well as Livingston's (1997) 'thinking about thinking' definition (p. 242).	X			X					
Motivation Strategies for Learning Questionnaire (MSLQ)	Self-regulated learning as including 'students' metacognitive strategies for planning, monitoring, and modifying their cognition' (p. 34).						X			X
Middle School Learning Strategies (MSLS)	Metacognitive strategies include activities that involve self-monitoring of the learning process, evaluation of learning strengths and weaknesses, and use of self-reflection at the end of the learning process.	X				X			X	X
Multiple Choice Questions	No precise definition for metacognition offered, but the author states: 'Theory on learning to learn emphasises that students who possess metacognitive knowledge of their learning processes can direct their own learning' (p. 170).	X				X				X
PISA 2009	Metacognition as an awareness and understanding of how one thinks and uses thinking strategies									X
Ongoing Task (OT) performance	Draws from Flavell's (1979) definition and then expands to include: 'In procedural metacognition, a further distinction has been made between metacognitive monitoring and control' (p. 621).						X			
Prospective Memory task (PM)	Draws from Flavell's (1979) definition and then expands to include: 'In procedural metacognition, a further distinction has						X			

	been made between metacognitive monitoring and control' (p. 621).									
Reasoning/Not Reasoning Task	Includes knowledge about the goals, strategies and demands of particular tasks			X		X				X
Science Meta Test (SMT)	No explicit definition offered.	X			X					X
Self-Evaluation	Metacognition described as 'thinking about thinking' (Flavell, 1979) with one's own thoughts become objects of thoughts themselves.	X								
Self-Induced Self-Reflective Thinking (SISRT)	Divides metacognition into metacognitive knowledge and the executive processes.	X								X
Swanson Metacognitive Questionnaire (MSQ)	Metacognition is defined as the knowledge and control one has over one's thinking and learning activities' (p. 306).	X		X						X
Systematical Observation (SO)	Metacognition refers to metacognitive knowledge and the metacognitive skills required to action that knowledge			X						
Relative Approximate Number System (ANS) Metacognition Task	Metacognitive monitoring as appropriate strategies, evaluating how much effort one put towards a strategy and assess whether you have answered correctly.					X				X
Think Aloud Protocols	No explicit definition offered.									
Train Track Task	Ability to monitor and control their cognition on task.			X				X		X
Triple Task Procedure in Mathematics (TTPM)	Zimmerman's model of forethought, performance and self-reflection.									

Table 3: Instrument list: recommendations and practicality

	Recommendation level of instrument considering administration at scale			
Name of the instrument	**Recommended**	**Conditionally recommended**	**Not recommended**	**Practicality of instrument**
Behaviour rating inventory of executive function (BRIEF)		X		Can be applied schoolwide as suitable for children aged 5 to 18. Uses a standardised instrument to capture qualitative aspects of children's executive function competence. Not specifically metacognitive
Children's Independent Learning Development (CHILD) checklist		X		Not practical at scale, but may be used by Reception teachers as a data collection method
Children's Awareness of Attention Through Drawing		X		Not practical at scale, practical for assessment of individual students or small groups.
Children's Perceived Use of SRL Inventory (CP-SRLI)	X			Practical at scale
Coding Scheme for Learning Protocols			X	Not practical at scale
Confidence Judgement Tasks			X	Not practical at scale
Confidence Judgement		X		Not practical at scale, but may be useful for Japanese language teachers in junior primary classes to assess students.
Confidence Judgement		X		Practical at small scale with groups of students
Creative Metacognitive Measure			X	Not practical at scale
Electronic Portfolio tool			X	Labour intensive and highly reliant on triangulation with qualitative data.
Metaprocess (MP) Questionnaire			X	Simple to administer on scale
Evaluation and Prediction Instrument (EPA2000)	X			Simple to administer on scale as all conducted through computer based program
Journalling		X		Not practical at scale, but may be practical at classroom level for teacher assessment of students in biology and mathematics. Not practical for younger students and those with limited literacy skills.
Junior Metacognitive Awareness Inventory (Jr MAI)	X			Practical at scale
Mathematics, School and Me		X		Practical at scale

Metacognitive Applied to a Physical Activity Scale	X			Not practical at scale. Useful for physical education teachers across individual and team sports.
Metacognitive Attribution Assessment (MAA)	X			Not practical at scale. May be practical for primary school teachers to administer in class, but not suitable for children with difficulty reading.
Metacognitive Awareness Inventory (MAI)		X		Practical at scale. Not validated for children.
Metacognitive Awareness of Reading Strategies Inventory (MARSI)	X			Practical at scale. Short self-report instrument which is useful for assessing and promoting learner awareness of underlying processes involved in reading.
Metacognitive Awareness Listening Questionnaire	X			Practical at scale
Metacogntive Baseline Questionnaire (MBQ)		X		Not practical on scale. Useful for senior school physics teachers to administer.
Metacognitive Knowledge - general (MK-general)			X	Practical at scale. The predictive power of metacognitive knowledge on students' achievement in reading and mathematics was relatively low.
Metacognitive Knowledge in Mathematics Questionnaire	X			Practical at scale
Metacognitive Knowledge Interview (McKI)		X		Not practical at scale. May be practical for junior primary school teachers or SSOs to administer one-on-one with students.
Metacognitive Knowledge - mathematics (MK-mathematics)	X			Practical at scale
Metacognitive Knowledge - reading (MK-reading)	X			Practical at scale
Metacognitive Knowledge Test	X			Not practical on scale. Can be administered to small groups or a classroom of students at any one time - test takes 15 minutes to complete
Metacognitive Monitoring	X			Practical at scale - computer based program
Metacognitive Orientation Learning Environment Scale-Science (MOLE-S)		X		Practical at scale. Suitable for use in science classrooms
Metacognitive Strategies Questionnaire (MStQ)		X		Practical at scale. Validity not high.

Metacognitive Self Regulation (MSR)		X		Questionnaire is practical at scale, but interview is not. Test is quick to administer in classroom environment, but two of the regulation items were incorrectly interpreted by 31% of the sample.
Metacognitive Skills and Knowledge Assessment (MSA)	X			Not practical at scale. May be practical for primary school teachers to administer in class, but not suitable for children with difficulty reading.
Metacomprehension Strategy Index (Durai et al.)			X	Not practical at scale. Can be administered by teacher by reading aloud to the students or have students read silently and answer questionnaire silently, author recommends the former.
Metacognitive Processes in Physical Education Questionnaire (MPIPEQ)			X	Not practical at scale. Suitable for use with a wide range of year levels with option to use data to monitor students' progress of metacognitive processes as they move through schooling.
Metacognitive Orientation Learning Environment Scale-Science (MOLE-S)	X			Practical at scale
Motivation Strategies for Learning Questionnaire (MSLQ)		X		Practical at scale. Validated for adults. Variations in the instrument exist.
Middle School Learning Strategies (MSLS)	X			Practical at scale
Multiple Choice Questions			X	Contains open-ended questions which are difficult to score
PISA 2009	X			Practical at scale
Ongoing Task (OT) performance			X	Not practical at scale
Prospective Memory task (PM)			X	Not practical at scale
Reasoning/Not Reasoning Task	X			Not practical at scale. Can be administered by teacher or SSO but requires testing students individually.
Science Meta Test (SMT)	X			Practical at scale
Self-Evaluation			X	Reliability of the pretest was low. Authors note that as instrument was not designed for use with students in middle secondary years, test validity for the age group is not confirmed.

Self-Induced Self-Reflective Thinking (SISRT)			X	Use of open ended questions makes it difficult to code
Swanson Metacognitive Questionnaire (MSQ)			X	Not practical at scale. Suitable for use within junior primary and could be administered by SSOs one-to-one with students.
Systematical Observation (SO)			X	Not practical at scale
Relative Approximate Number System (ANS) Metacognition Task	X			Practical at scale. Suitable for younger students. Scripts freely available
Think Aloud Protocols			X	Not practical at scale
Train Track Task		X		Not practical at scale. Good for one-on-one exploration. Instrument is used in conjunction with CHILD questionnaire
Triple Task Procedure in Mathematics (TTPM)			X	Practical at scale

Summary of findings

Measuring components of Metacognition

In this review, few instruments fully addressed all facets of metacognition, owing to its intricate nature and implicit characteristics. Surveys were frequently employed to investigate metacognitive knowledge and, to some extent, metacognitive monitoring. Notably, the 'Junior Metacognitive Awareness Inventory' (Jnr MAI - Sperling et al., 2002) and 'Children's Perceived Use of SRL Inventory (CP-SRLI - Vandevelde et al., 2013) stood out; even though they intersect with measures of SRL, they pinpointed behaviors indicative of students' proficient use of metacognition. However, surveys often come with a potential for social desirability bias, as students must recognise and report their own processes.

Tools tailored for observing students were also pinpointed such as the 'CHILD checklist' (Whitebread et al., 2009), and these appear more suitable for younger students where literacy and developmental challenges might affect survey use. However, the recurring issue is discerning internal metacognitive processes from observed external behaviors. Few researchers have successfully navigated this challenge. Furthermore, it's worth noting that the observational measures examined in this study can often be constrained by the significant personnel or workforce required for their implementation.

When exploring metacognitive monitoring, the concept of 'judgements of learning' and 'confidence judgements' was quite prevalent in the literature. Sometimes these were operationalized within digital contexts such as the 'EPA2000' (De Clercq et al., 2000) and the 'Relative Approximate Number System Metacognition Task' (Baer & Odic, 2020). In these contexts, students anticipated their performance on a task and then evaluated their actual achievement after completing it. Correlations between prospective, retrospective and actual achievements were then compared. This simple method was effective, but it could be argued that it does not always identify error detection skills which are key to improving problem solving strategies.

Domain specific vs domain general instruments

Many of the tools reviewed that were utilized in multiple studies were domain general in nature. These types of instruments can be employed simply and are repeatedly validated but they ignore the important consideration of domain specificity. As such it is important to highlight those that are more discipline focused such as the 'Metacognitive Awareness of Reading Strategies Inventory' (Davis et al., 2017; Mokhtari & Reichard, 2002; Onde et al., 2022), the 'Metacognitive Knowledge in Reading and

Mathematics' self reports (Neuenhaus et al., 2011), the 'Metacognitive Knowledge in Mathematics Questionnaire' (Anastasia Efklides & Symeon P. Vlachopoulos, 2012), and the 'Metacognitive Processes in Physical Education Questionnaire' (Michele Settanni et al., 2012). These more focused studies tended to make less expansive claims but their findings could be argued to be more indicative of common behaviours observed in classrooms.

Developmental level

Many of the tools used in primary and secondary school contexts are targeted specifically at this developmental level but our analysis identified a couple of tools, such as the 'Metacognitive Awareness Inventory' (Schraw & Dennison, 1994) and the "Motivation Strategies for Learning Questionnaire' (Pintrich & De Groot, 1990), that have only been validated in older populations. Despite the popularity of these tools, it is important to note these instruments and their recent adaptations need further validation and testing, especially for children.

Of the tools identified 3 could cater for preschool students, 20 for primary students and 23 for secondary students. Often there was significant overlap, but no instruments covered the whole range of these year levels. Instead attention seems to have been placed on late childhood and early adolescence, possibly related to the greater mediating factor of metacognition between executive function and SRL (Effeney et al., 2013), but more likely due to their ability to comprehend and provide consistent results when using metacognitive measures.

Traditionally, younger students were believed to exhibit low metacognitive activity. However, recent research suggests this perception may stem from the challenges in evaluating their knowledge and skills, primarily due to difficulties they face in articulating their thought processes (Smith-Ferguson, 2020). The three tools highlighted in the analysis sought to overcome this limitation through video observation (CHILD checklist), simplified wording of questions (Metaprocess questionnaire) and interview (Metacognitive Knowledge Interview). None of these instruments addressed metacognitive monitoring.

Context

Very few instruments identified within our analysis were administered clinically but some involved the removal of students from their regular class in order for closer observation (e.g. Systematical Observation - Veenman, Kok, & Blöte, 2005). Whilst this limits the scalable use of the instrument, and possibly the ecological validity of the findings, these tools may be useful for focused testing exploring the actual mechanisms of metacognition.

More commonly however tools were delivered in the form of surveys or digital tasks. These can be applied in various contexts and the structure would be recognisable to older students. However, they could pose challenges when assessing the metacognitions of younger students.

Some instruments, like those that used journaling (e.g. Glogger, Schwonke, Holzäpfel, et al., 2012) or confidence judgements (e.g. Destan et al., 2017b; Roebers et al., 2009), were seamlessly incorporated into students' daily learning, making them attuned to the local context. However, this specificity might also make them challenging to adapt to different contexts.

Implications/Recommendations

Our conclusion is that there is no perfect tool for every situation. The research question guiding any measurement will dictate which instrument is most suitable but none of those analysed have the demonstrated validity and reliability to measure a wide range of metacognitive knowledge and skills in various contexts and with varied audiences. Instead, a more bespoke approach should be taken where the instrument matches the intentions of the intervention or application.

Additionally, many of these instruments are not mutually exclusive. Tools that explore metacognitive knowledge and control which are often indirect can be coupled with those that are more direct and task oriented to explore metacognitive monitoring. Tools more suitable for younger students, such as those involving teacher and parent observations, can be complemented by self-identification tools that may be more suitable to older students.

Nevertheless, we recommend the following tools, which exhibit the strongest evidence for reliability, validity, practicality, and comprehensive data collection. Each is explored with reference to what it is measuring and the relevant caveats. This selection represents a wide range of age groups and metacognitive foci.

- **Children's Perceived Use of SRL Inventory (CP-SRLI):** 75 item self-report questionnaire across 15 subscales for 10-12 year olds on metacognitive knowledge and control. Easily scalable and effectively tested for validity on a large sample of students. Subject to the typical problems of self-report measures. Inventory included in the appendix of article by Vandevelde et al. (2013).

- **Junior Metacognitive Awareness Inventory (Jnr MAI):** Adaptation of the Metacognitive Awareness Inventory (MAI) using an 18 item self-report questionnaire with 5 point Likert scale responses. Commonly used with 7-15 year old students and active in the measurement of both metacognitive knowledge and aspects of metacognitive control. Subject to the typical problems of self-report measures. Inventory included in the appendix of article by Sperling et al. (2002).
- **Metacognitive Awareness of Reading Strategies Inventory (MARSI)**: A domain specific 30 item questionnaire exploring three factors of metacognitive knowledge and control in relation to reading - global reading strategies, problem solving and support reading strategies. Easily scalable and aimed at 11 to 18 year olds. Useful within the literacy but fails to represent either metacognitive monitoring or wider metacognitive knowledge. Subject to the typical problems of self-report measures. Inventory included in the appendix of article by Mokhtari and Reichard (2002).
- **Metacognitive monitoring**: Computerised self report task exploring mathematics and spelling. Students aged 7-9 report their judgements of accuracy after completing each answer of a mathematics and spelling test. Scoring is automatic and explores the area of metacognitive monitoring not covered by many of the other tools. Whilst students are self reporting, the fact that this is a measurement of their perceived understanding makes this a more relevant tool. Description and measurement of the tool in article by Bellon et al. (2020b). Project part of the OSF run by the Centre for Open Science and therefore access to software may be possible.
- **Children's Independent Learning Development (CHILD) checklist**: Video analysis of 3-5 year-olds using 22 criteria from literature on metacognitive control, encompassing both verbal and non-verbal behaviors. Time consuming and little validity testing, but appropriate for younger students. Checklist and coding scheme included in the appendices of the article by Whitebread et al. (2009).

Conclusion

Quantifying metacognition presents complexities owing to its implicit character and the multitude of unresolved questions in educational research, including its domain generality and the interplay among its essential components. However, its importance demands our attention and action as evidence points towards the key role of metacognition in self-regulated learning and consequently lifelong academic achievement. This review has analysed 48 documents resulting from the original inclusion criteria to identify 52 prospective research instruments to measure metacognition but ultimately the decision as to the best instrument relates to the aims of the researchers and the nature of the intervention.

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Appendix: Databases searched and limits applied

Table 4: Databases searched, search strings and limitations applied

Database	**Search string**	**Limits applied**	***n***	***n*-duplicates**
Cochrane Library	Title, abstract, keyword-(metacogniti* OR meta-cogniti*) AND Title, abstract, keyword-(measure OR assess* OR evaluat* OR instrument) AND Title, abstract, keyword-(student OR pupil OR child*) AND Title, abstract, keyword-(school)	Publication date: after 1 January 2003 Search word variations: On Language: English	72	64
ERIC	ab(metacogniti* OR meta-cogniti*) AND ab(measure OR assess* OR evaluat* OR instrument) AND ab(student OR pupil OR child*) AND ab(school)	Publication date: after 1 January 2003 Language: English Education level: Early childhood education, Elementary education, Elementary secondary education, Grade 1, Grade 2, Grade 3, Grade 4, Grade 5, Grade 6, Grade 7, Grade 8, Grade 9, Grade 10, Grade 11, Grade 12, High school equivalency programs, High schools, Intermediate grades, Junior high schools, Kindergarten, Middle schools, Primary education, Secondary education Source type: Scholarly journals, Dissertations & theses, Reports and Books	690	686
Google (grey literature)	(metacogniti* OR meta-cogniti*) AND (measure OR assess* OR evaluat* OR instrument) AND (student OR pupil OR child*) AND (school) AND (government) AND (report)	-	94	92
ProQuest Central	ABS(metacogniti* OR meta-cogniti*) AND ABS(measure OR assess* OR evaluat* OR instrument) AND ABS(student OR pupil OR child*) AND ABS(school)	Source type: Scholarly journals, Dissertations and theses Language: English Publication date: 1 January 2023 onwards Location: Austria, Australia, Belgium, Canada, Chile, Colombia, Costa Rica, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkiye, the United Kingdom and the United States Subject (excluded): Agricultural development, Agricultural land, Agricultural management, Animal migration	37	37
PubMed	Title/abstract-(metacogniti* OR meta-cogniti*) AND Title/abstract-(measure OR assess OR evaluate OR instrument) AND Title/abstract-(student OR pupil OR child*) AND Title/abstract-(school)	Years: 2003 – 2023 Article type: Research articles Subject areas: Social Sciences, Psychology, Arts and Humanities Language: English	10	8

Science Direct	Title, abstract or author-specified words-(metacognition) AND Title, abstract or author-specified words-(measure OR assess OR evaluate OR instrument) AND Title, abstract or author-specified words-(student OR child) AND Title, abstract or author-specified words-(school) Title, abstract or author-specified words-(metacognitive) AND Title, abstract or author-specified words-(measure OR assess OR evaluate OR instrument) AND Title, abstract or author-specified words-(student OR child) AND Title, abstract or author-specified words-(school) *Wildcard not supported in this database and limitation on Boolean terms permitted, so two search strings were applied.	Years: 2003 – 2023 Article type: Research articles Subject areas: Social Sciences, Psychology, Arts and Humanities Language: English	50	28
Scopus	ABS(metacogniti* OR meta-cogniti*) AND ABS(measure OR assess* OR evaluat* OR instrument) AND ABS(student OR pupil OR child*) AND ABS(school)	Year: 2003 to 2023 Language: English Subject area: Psychology, Social sciences Document type: Article, Review, Book chapter Keyword: Child, Students, Education, Educational measurement, Childhood, Measurement, Metacognitive knowledge Location: Austria, Australia, Belgium, Canada, Chile, Colombia, Costa Rica, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkiye, the United Kingdom and the United States Source type: Scholarly journals, Dissertations and theses, Reports and books	130	106
A+ Education	ABS(metacogniti* OR meta-cogniti*) AND ABS(measure OR assess* OR evaluat* OR instrument) AND ABS(student OR pupil OR child*) AND ABS(school)	Publication date: 2003 – 2023 Language: English Resource type: Journal article, Book, Thesis Subject: Metacognition	10	7

Table 5: Total records, duplications and exclusions by database

Database searched	**Total records**	**Post de-duplication**	**Excluded** **(first screening)**	**Unavailable**	**Records remaining**
A+ education	10	7	3	0	4
Cochrane Library	72	64	59	3	2
ERIC	690	686	566	9	111
Google (grey literature)	94	92	85	0	7
ProQuest Central	37	37	21	1	15
PubMed	10	8	8	0	0
ScienceDirect	50	28	15	0	13
Scopus	130	106	49	3	54
TOTAL	**1093**	**1028**	**806**	**16**	**206**

Appendix: Data Extraction tables

Table 6: Behaviour Rating Inventory of Executive Function (BRIEF)

Name and type of instrument: Behaviour Rating Inventory of Executive Function (BRIEF)					
Aspect of metacognition measured: Metacognitive control					
First record (full reference, must have detailed methods and details of reliability and validity): Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L. (2000). Test review behavior rating inventory of executive function. *Child Neuropsychology, 6*(3), 235-238.					
Definition of metacognition associated with original development measure: Executive functions					
Aim of the study: Instrument validation and standardisation					
Description of the tool or method: • 86 question parent form • 86 question teacher form • The answer sheets use a 3-point scale (never, sometimes, often) • The subdomains include Initiate, Working Memory, Plan/Organise, Organisation of Materials, and Monitor. They provide a composite metacognitive index.					
Sample size: n=1419 parent forms n=720 teacher forms	**Age range and average age (if applicable):** Children aged between 5 and 18	**Setting of the study:** Schools, USA			
Link to metacognition:					
Metacognition for something else (e.g., maths achievement)	Internally testing metacognition (e.g., solely measuring this or an aspect of it)	Testing the tool (e.g., assessing its reliability or validity) X	Extra info (if applicable)		
Type of study:					
Pre/Post-test	Longitudinal	Experimental	Other X	Unclear	Extra info

Reliability:	**Validity:**
Reliability studies are satisfactory. The Cronbach alpha coefficient measure of internal consistency ranged from .80±.98 for parent and teacher form and clinical and normative samples. Parent-teacher interrater agreement was only moderate but was indicated to be consistent with expectation for different environmental settings, r=32 (range: .15±50). Test-retest reliability correlation across clinical scales for a Parent Form normative subsample was r=81 (range: .76±.85) for an average interval of two weeks. Metacognitive Index (MCI) retest correlation is .88. Teacher Form normative subsample correlation was r=.87 (range: .83±.92), and MCI retest correlation was .90, with a mean interval of 3.5 weeks.	

Administration (who administers measure/training required):
Teachers and parents

Strengths:

- Uses a standardised instrument to capture the qualitative aspects of children's executive function competence.
- Due to age range suitability, instrument can be applied school wide.
- Strong reliability of instrument.
- Ease of administration and scoring.
- Solid statistical support for its use.

Weaknesses:

- Limited use of instrument with 18-year-olds.
- Assesses a process (i.e., metacognitive control) based on post-event evaluations provided by an individual other than the one who directly experienced the event.
- More focused on executive function than metacognition.

Adaptions made to original instrument:	**Record:**
BRIEF translated into Japanese.	Momoda, M., Yoshizaki, A., Nagatani, F., Nishimura, T., Taniike, M., & Mohri, I. (2019). Impaired executive function in junior high school students with excess sleep time. Vulnerable Children and Youth Studies, 14(2), 116–128. https://doi.org/10.1080/17450128.2019.1580404

Related records (5):

Cirino, P. T., Ahmed, Y., Miciak, J., Taylor, W. P., Gerst, E. H., & Barnes, M. A. (2018). A Framework for Executive Function in the Late Elementary Years. *Neuropsychology*, 32(2), 176–189. https://doi.org/10.1037/neu0000427

Flook, L., Smalley, S. L., Kitil, M. J., Galla, B. M., Kaiser-Greenland, S., Locke, J., Ishijima, E., & Kasari, C. (2010). Effects of Mindful Awareness Practices on Executive Functions in Elementary School Children. *Journal of Applied School Psychology*, 26(1), 70–95. https://doi.org/10.1080/15377900903379125

Gioia, G. A., Isquith, P. K., Retzlaff, P. D., & Espy, K. A. (2002). Confirmatory Factor Analysis of the Behavior Rating Inventory of Executive Function (BRIEF) in a Clinical Sample. *Child Neuropsychology*, 8(4), 249–257. https://doi.org/10.1076/chin.8.4.249.13513

Lemberger, M. E., & Clemens, E. V. (2012). Connectedness and Self-Regulation as Constructs of the Student Success Skills Program in Inner-City African American Elementary School Students. Journal of Counseling and Development, 90(4), 450–458. https://doi.org/10.1002/j.1556-6676.2012.00056.x

Rizzo, P., Steinhausen, H. C., & Drechsler, R. (2010). Self-Perceptions of Self-Regulatory Skills in Children Aged Eight to 10 Years: Development and Evaluation of a New Self-Rating Scale. *Australian Journal of Educational & Developmental Psychology*, *10*, 123-142.

Table 7: Children's Independent Learning Development checklist

Name and type of instrument:

Children's Independent Learning Development (CHILD) checklist

Aspect of metacognition measured:

Metacognitive control

First record (full reference, must have detailed methods and details of reliability and validity):

Whitebread, D., Coltman, P., Pasternak, D. P., Sangster, C., Grau, V., Bingham, S., Almeqdad, Q., & Demetriou, D. (2009). The development of two observational tools for assessing metacognition and self-regulated learning in young children. *Metacognition and Learning*, 4(1), 63–85. https://doi.org/10.1007/s11409-008-9033-1

Definition of metacognition associated with original development measure:

Uses Flavell (1979) and Brown (1987) to describe metacognition as metacognitive knowledge, monitoring and control.

Aim of the study:

Development of observational instruments for the assessment of metacognition and self-regulation.

Description of the tool or method:

- Video of students working individually and in groups is coded using 22 statements from the literature. Students are scored from 1 (always) to 4 (never).

Sample size:	**Age range and average age (if applicable):**	**Setting of the study:**
n=1440	Children aged 3 to 5	Preschool and schools, UK

Link to metacognition:

Metacognition for something else (e.g., maths achievement)	Internally testing metacognition (e.g., solely measuring this or an aspect of it)	Testing the tool (e.g., assessing its reliability or validity)	Extra info (if applicable)
		X	

Type of study:

Pre/Post-test	Longitudinal	Experimental	Other	Unclear	Extra info
		X (Quasi)			

Reliability:	**Validity:**
Cronbach's alpha of .97 Test-retest Compared frequency of codes but Inter-rater score not recorded Tested again in Germany and Cyprus	

Administration (who administers measure/training required): Teachers Training: Initial training related to metacognition and self-regulation.	
Strengths: • Use of video recording captures non-verbal behaviour in development of young children's conceptual understandings and self-regulatory processes. • Provides an observational checklist designed specifically for teachers to use in conjunction with video recordings. • Verbal self-report data relies on extent of individual's capability and verbal fluency to report on own mental processes. This instrument introduces use of checklist to assess non-verbal behaviours to help compensate. • Measures a process as it is happening.	
Weaknesses: • Time involved in watching video-recorded events. • Children's goals and intentions need to be inferred. • Only directly observable behaviours can be coded. • Not thoroughly validated.	
Adaptions made to original instrument:	**Record:**
N/A	N/A
Related records: 2 Bryce, D., Whitebread, D. & Szűcs, D. (2015). The relationships among executive functions, metacognitive skills and educational achievement in 5 and 7 year-old children. *Metacognition Learning* **10**, 181–198 https://doi.org/10.1007/s11409-014-9120-4 NSW Department of Education. (2020). *Metacognition - a key to unlocking learning: key insights and implications for teaching practice*. Retrieved from https://education.nsw.gov.au/content/dam/main-education/teaching-and-learning/education-for-a-changing-world/media/documents/Metacognition_key_messages.pdf	

Table 8: Children's Awareness of Attention Through Drawing

<table>
<tr><td colspan="7">Name and type of instrument:
Children's Awareness of Attention Through Drawing</td></tr>
<tr><td colspan="7">Aspect of metacognition measured:
Metacognitive knowledge</td></tr>
<tr><td colspan="7">First record (full reference, must have detailed methods and details of reliability and validity):
Pezzica, S., Pinto, G. , Bigozzi, L., & Vezzani, C. (2016). Where is my attention? Children's metaknowledge expressed through drawings, Educational Psychology, 36(4). 616-637.</td></tr>
<tr><td colspan="7">Definition of metacognition associated with original development measure:
Beliefs about mental functioning</td></tr>
<tr><td colspan="7">Aim of the study:
To assess the developmental pattern of the metacognitive knowledge of attention in Italian primary school students.</td></tr>
<tr><td colspan="7">Description of the tool or method:
Students drew two images on A4 sheets of paper in 60 minutes representing attentiveness and inattentiveness.
Coding scheme for self-drawn images. Constructs explored include behavioural awareness, pragmatic awareness, cognitive awareness, social awareness and emotional awareness.</td></tr>
<tr><td colspan="2">Sample size:
n=95</td><td colspan="2">Age range and average age (if applicable):
Children aged 8 to 10</td><td colspan="3">Setting of the study:
Schools, Italy</td></tr>
<tr><td colspan="7">Link to metacognition:</td></tr>
<tr><td>Metacognition for something else (e.g., maths achievement)</td><td colspan="2">Internally testing metacognition (e.g., solely measuring this or an aspect of it)
X
Seeing how students think about their own thinking in relation to attention/inattention.</td><td>Testing the tool (e.g., assessing its reliability or validity)</td><td colspan="3">Extra info (if applicable)</td></tr>
<tr><td colspan="7">Type of study:</td></tr>
<tr><td>Pre/Post-test</td><td colspan="2">Longitudinal</td><td>Experimental</td><td>Other
X
{Testing the instrument)</td><td>Unclear</td><td>Extra info</td></tr>
</table>

<table>
<tr><td>Reliability:</td><td colspan="2">Validity:</td></tr>
<tr><td>No real reliability information.</td><td colspan="2">Face validity</td></tr>
<tr><td colspan="3">Administration (who administers measure/training required):
Teachers</td></tr>
<tr><td colspan="3">Strengths:
Uses pictorial representations to facilitate communication and access knowledge of young children.
Instrument provides information on children’s metaknowledge of attention, including behavioural, emotional and contextual.
Overcomes common language difficulties.</td></tr>
<tr><td colspan="3">Weaknesses:
No real reliability information.
Can be affected by unrelated skills such as fine motor skills.</td></tr>
<tr><td>Adaptions made to original instrument:</td><td colspan="2">Record:</td></tr>
<tr><td>N/A</td><td colspan="2">N/A</td></tr>
<tr><td colspan="3">Related records: N/A</td></tr>
</table>

Table 9: Children's Perceived use of SRL Inventory

Name and type of instrument:

Children's Perceived use of SRL Inventory (CP-SRLI)

Aspect of metacognition measured:

Metacognitive knowledge

First record (full reference, must have detailed methods and details of reliability and validity):

Vandevelde, S., Van Keer, H., & Rosseel, Y. (2013). Measuring the complexity of upper primary school children's self-regulated learning: A multi-component approach. *Contemporary Educational Psychology*, 38(4), 407–425. https://doi.org/10.1016/j.cedpsych.2013.09.002

Definition of metacognition associated with original development measure:

Not explicit but knowledge of oneself, tasks and strategies implied.

Aim of the study:

Validation of tool for measuring SRL in primary school students.

Description of the tool or method:

- 75 item questionnaire.

Sample size:	**Age range and average age (if applicable):**	**Setting of the study:**
Sample 1, n=966 Sample 2, n=723	Children aged 10 to 12 (5th and 6th grade)	School, Belgium

Link to metacognition:

Metacognition for something else (e.g., maths achievement)	Internally testing metacognition (e.g., solely measuring this or an aspect of it)	Testing the tool (e.g., assessing its reliability or validity)	Extra info (if applicable)
		X	

Type of study:

Pre/Post-test	Longitudinal	Experimental	Other	Unclear	Extra info
			X (Develop and validate tool)		

Reliability:	**Validity:**
Review by teacher and expert panel Internal consistency using Bentler's *p*	Content validity by five researchers in the educational sciences. Cognitive interviews were conducted with 14 of the students. Exploratory and confirmatory factor analysis used Invariance testing

Administration (who administers measure/training required):
Teachers

Could be administered across all DfE primary schools

Strengths:
- Useful for large-scale studies aimed at mapping students' perceptions of their self-regulatory strategy use.
- Valuable instrument for assessing, describing and investigating SRL in upper primary school children.
- A tool to diagnose and remediate SRL.
- Strong validation of tool.

Weaknesses:
- As with all self-report measures, tool relies on a student's ability to verbalise their thoughts.
- Higher focus on self-regulation than metacognition.

Adaptions made to original instrument:	**Record:**
N/A	N/A

Related records (1):

Baas, D., Castelijns, J., Vermeulen, M., Martens, R., & Segers, M. (2015). The relation between Assessment for Learning and elementary students' cognitive and metacognitive strategy use. *British Journal of Educational Psychology*, 85(1), 33–46. https://doi.org/10.1111/bjep.12058

Table 10: Coding Scheme for Learning Protocols

Name and type of instrument:

Coding Scheme for Learning Protocols

Aspect of metacognition measured:

Metacognitive monitoring

First record (full reference, must have detailed methods and details of reliability and validity):

Moning, J., & Roelle, J. (2021). Self-regulated learning by writing learning protocols: Do goal structures matter? *Learning and Instruction, 75*, 101486. doi:https://doi.org/10.1016/j.learninstruc.2021.101486

Definition of metacognition associated with original development measure:

No explicit definition provided.

Aim of the study:

"… understanding the role of the contextual factor goal structure for the optimisation of self-regulated learning by learning protocol writing" (p. 1).

Description of the tool or method:

- Developed a coding scheme to assess "… the quantity and quality of metacognitive processes. In terms of quantity, we counted the number of positive monitoring episodes (i.e., statements related to comprehension), negative monitoring episodes (i.e., statements related to comprehension difficulties), self-diagnosis episodes (i.e., identifying cues for one's comprehension or comprehension difficulties), and regulation episodes (i.e., statements related to implemented or planned remedial processes)" (p. 486).
- Quality assessed by "… using an 8-point rating scale ranging from 1 (*very low quality*) to 8 (*very high quality*). Students' metacognitive processes were rated to be of high quality if they described which content was understood or not understood in a relatively concrete manner (i.e., *"I do not understand the difference between positive and negative punishment"* was rated higher than *"I do not under- stand punishment*")" (p. 486).

Sample size:	**Age range and average age (if applicable):**	**Setting of the study:**
n=166	Children aged 13 to 16 (grade 9)	Schools, Germany

Link to metacognition:

Metacognition for something else (e.g., maths achievement)	Internally testing metacognition (e.g., solely measuring this or an aspect of it)	Testing the tool (e.g., assessing its reliability or validity)	Extra info (if applicable)
X		X	

Type of study:					
Pre/Post-test X	Longitudinal	Experimental	Other X	Unclear	Extra info

Reliability:	**Validity:**
Cronbach's alpha used to assess interrater reliability of coding scheme.	

Administration (who administers measure/training required):
Teachers

Strengths:

Weaknesses:

- Student participants indicated that writing time of 25 minutes was too short**.**
- Quality and quantity of metacognitive processes were found to be relatively low; it is unclear from study as to whether this is due to instrument design or if participating students had limited practice in learning protocol writing.
- Time to train students in protocol writing.

Adaptions made to original instrument:	**Record:**
N/A	N/A

Related records: 0

Table 11: Confidence Judgement Tasks

<table>
<tr><td colspan="6">Name and type of instrument:
Confidence Judgment Tasks</td></tr>
<tr><td colspan="6">Aspect of metacognition measured:
Metacognitive monitoring</td></tr>
<tr><td colspan="6">First record (full reference, must have detailed methods and details of reliability and validity):
Contreras, M. J., Meneghetti, C., Uttal, D. H., Fernández-Méndez, L. M., Rodán, A., & Montoro, P. R. (2020). Monitoring the own spatial thinking in second grade of primary education in a Spanish school: Preliminary study analyzing gender differences. Education Sciences, 10(Irct20201107049293N), 1–14. https://doi.org/10.3390/educsci10090237</td></tr>
<tr><td colspan="6">Definition of metacognition associated with original development measure:
Metacognition defined as “... a reflection about our own mental processes that can be produced in a more or less conscious way”.</td></tr>
<tr><td colspan="6">Aim of the study:
Explore the metamemory processes of primary school children</td></tr>
<tr><td colspan="6">Description of the tool or method:
• Students conduct a task and then participants were interviewed about how they had performed. They gave responses from 1 (minimum confidence) to 4 (maximum).</td></tr>
<tr><td>Sample size:
n=33</td><td colspan="2">Age range and average age (if applicable):
Children aged 7</td><td colspan="3">Setting of the study:
Schools, Spain</td></tr>
<tr><td colspan="6">Link to metacognition:</td></tr>
<tr><td>Metacognition for something else (e.g., maths achievement)
X
(Spatial tasks)</td><td>Internally testing metacognition (e.g., solely measuring this or an aspect of it)
X
(Metacognitive judgments)</td><td>Testing the tool (e.g., assessing its reliability or validity)</td><td colspan="3">Extra info (if applicable)</td></tr>
<tr><td colspan="6">Type of study:</td></tr>
<tr><td>Pre/Post-test</td><td>Longitudinal</td><td>Experimental</td><td>Other
X</td><td>Unclear</td><td>Extra info</td></tr>
<tr><td colspan="3">Reliability:</td><td colspan="3">Validity:</td></tr>
<tr><td colspan="3"></td><td colspan="3">‘The authors found reliability coefficients of 0.86 for Level 1 of this task’ (p. 6).</td></tr>
</table>

Administration (who administers measure/training required): Teacher Trial items displayed on a digital board.	
Strengths: • Instrument could be applied to multiple subjects	
Weaknesses: • Requires time for interviewing students post-test. • Reliability not assessed and limited validation of instrument.	
Adaptions made to original instrument:	**Record:**
N/A	N/A
Related records: 0	

Table 12: Confidence Judgments (1)

Name and type of instrument: Confidence Judgments			
Aspect of metacognition measured: Metacognitive monitoring			
First record (full reference, must have detailed methods and details of reliability and validity): Destan, N., Spiess, M. A., de Bruin, A., van Loon, M., & Roebers, C. M. (2017). 6-and 8-year-olds' performance evaluations: Do they differ between self and unknown others? *Metacognition and Learning*, 12(3), 315–336. https://doi.org/10.1007/s11409-017-9170-5			
Definition of metacognition associated with original development measure: Metacognitive monitoring – the ability to monitor and evaluate own performance.			
Aim of the study: Explore kindergarteners and second grader's ability to monitor and evaluate their own work			
Description of the tool or method: • Students learning Kanji (Japanese characters representing entire words) on tablet. They then had to recognise the Kanji and provide confidence judgements on a 7-point scale ('very unsure' to 'very sure'). They then got feedback and did performance-based judgements using the new knowledge of what was correct and what was wrong. They then gave credit to their answers based on how they thought they went. • Later the students were asked to rate another boy or girl (made up) on their performance on the same task and suggest credits.			
Sample size: n=101	**Age range and average age (if applicable):** Children aged 6 to 8.		**Setting of the study:** Schools, Switzerland
Link to metacognition:			
Metacognition for something else (e.g., maths achievement)	Internally testing metacognition (e.g., solely measuring this or an aspect of it) X (Exploring metacognitive monitoring)	Testing the tool (e.g., assessing its reliability or validity)	Extra info (if applicable)

<table>
<tr><td colspan="6">Type of study:</td></tr>
<tr><td>Pre/Post-test</td><td>Longitudinal</td><td>Experimental</td><td>Other
X
(Testing of the tool)</td><td>Unclear</td><td>Extra info</td></tr>
<tr><td colspan="3">Reliability:</td><td colspan="3">Validity:</td></tr>
<tr><td colspan="3">Not specified</td><td colspan="3">Face validity</td></tr>
<tr><td colspan="6">Administration (who administers measure/training required):
Trained experimenters</td></tr>
<tr><td colspan="6">Strengths:
• Involves an element of play in the testing which is ideal for young children.
• Shows how children evaluate own performance compared to how they evaluate a peer’s performance; important for academic contexts such as group work, collaboration and cooperative learning.</td></tr>
<tr><td colspan="6">Weaknesses:
• Limited assessment of reliability and validity.
• Time intensive as students tested individually for 20 to 30 minutes each.</td></tr>
<tr><td colspan="2">Adaptions made to original instrument:</td><td colspan="4">Record:</td></tr>
<tr><td colspan="2">N/A</td><td colspan="4">N/A</td></tr>
<tr><td colspan="6">Related records: 0</td></tr>
</table>

Table 13 13: Confidence Judgements (2)

Name and type of instrument: Confidence Judgments					
Aspect of metacognition measured: Metacognitive monitoring					
First record (full reference, must have detailed methods and details of reliability and validity): Roebers, C. M., Schmid, C., & Roderer, T. (2009). Metacognitive Monitoring and Control Processes Involved in Primary School Children's Test Performance. *British Journal of Educational Psychology, 79*(4), 749-767. https://doi.org/10.1348/978185409X429842					
Definition of metacognition associated with original development measure: Provides a literature review for the concept of metacognition, but no specific definition provided.					
Aim of the study: 'The present longitudinal study aimed at pursuing two major research questions: First, inter-relations between young elementary school children's metacognitive abilities, EF, and self-perceptions in the form of self-concept are explored' (p. 156).					
Description of the tool or method: • Multi-phase task in context of spelling. • Phase 1: children presented with 22 schematic pictures of sample objects and animals. Children instructed to write corresponding word next to picture. • Phase 2: children give confidence judgments to every word they had written down, resulting in 18 confidence ratings per participant.					
Sample size: n=209	**Age range and average age (if applicable):** Children with a mean age of 7.5 years		**Setting of the study:** Schools, Switzerland		
Link to metacognition:					
Metacognition for something else (e.g., maths achievement)	Internally testing metacognition (e.g., solely measuring this or an aspect of it) X	Testing the tool (e.g., assessing its reliability or validity)	Extra info (if applicable)		
Type of study:					
Pre/Post-test	Longitudinal X	Experimental X (Control group)	Other	Unclear	Extra info

<table>
<tr><td colspan="2">Reliability:</td><td>Validity:</td></tr>
<tr><td colspan="2">Not specified</td><td>Ecological validity</td></tr>
<tr><td colspan="3">Administration (who administers measure/training required):
Researchers, but could be administered by teachers</td></tr>
<tr><td colspan="3">Strengths:
• Scoring introduced through a game-like scheme.
• Can be delivered to groups of students at any one time.</td></tr>
<tr><td colspan="3">Weaknesses:
• No assessment of reliability or validity of instrument.</td></tr>
<tr><td>Adaptions made to original instrument:</td><td colspan="2">Record:</td></tr>
<tr><td>N/A</td><td colspan="2">N/A</td></tr>
<tr><td colspan="3">Related records: 2

Roebers, C. M., & Spiess, M. (2017). The Development of Metacognitive Monitoring and Control in Second Graders: A Short-Term Longitudinal Study. Journal of Cognition and Development, 18(1), 110-128. doi:https://doi.org/10.1080/15248372.2016.1157079

Roebers, C. M., van Loon, M. H., Buehler, F. J., Bayard, N. S., Steiner, M., & Aeschlimann, E. A. (2021). Exploring psychometric properties of children' metacognitive monitoring. Acta Psychologica, 220. doi:10.1016/j.actpsy.2021.103399</td></tr>
</table>

Table 14: Metaprocess questionnaire

Name and type of instrument:

Metaprocesses (MP) questionnaire

Aspect of metacognition measured:

Metacognitive knowledge and control

First record (full reference, must have detailed methods and details of reliability and validity):

Mevarech, Z. R., & Paz-Baruch, N. (2022). Meta-creativity: what is it and how does it relate to creativity?. *Metacognition and Learning*, *17*(2), 427-441.

Definition of metacognition associated with original development measure:

'Metacognition is a broad umbrella of processes, including planning, control, monitoring, and evaluation (Cross & Paris, 1988; Schraw & Moshman, 1995; Whitebread et al., 2009) … Bruch (1988) defined meta-creativity as being aware of thoughts and feelings during a creative experience. Mevarech (2018) broadened the concept by including the deliberate implementation of strategies that have the potential to foster creativity, in addition to awareness. Mevarech (2018) argued that creative people regulate their creative processes; they plan ahead, look for additional or new ideas for solving a task, and reflect on their creative activities. Using the acronym CREATE, Mevarech (2019) identified the basic components of meta-creativity:

- Comprehend the core problem and subproblems.
- Reconstruct connections.
- Explore, explain, and experiment.
- Additional strategies, methods, technologies, or ideas.
- True-but: Reservations and constraints about the solution.
- Evaluation' (p. 429)

Aim of the study:

'The present study aims to investigate the extent to which elementary school students with low, medium, or high levels of creativity also differ in their implementation of metacognitive and meta-creative processes during creative thinking. We hypothesized that students scoring high on creativity would implement MP strategies to a greater extent than students with a medium level of creativity who, in turn, would implement MP strategies to a greater extent than students with a low level of creativity' (p. 431).

Description of the tool or method:

- The 14-item questionnaire.
- Used to assess students' implementation of metaprocesses, I.e., metacognitive and meta-creative processes.
- All items were scored on a 4-point Likert scale ranging from 1 (not at all true of me) to 4 (very true of me).

Sample size:	**Age range and average age (if applicable):**	**Setting of the study:**
n=221	Children in Years 4, 5 and 6	Schools, Israel

<table>
<tr><td colspan="6">Link to metacognition:</td></tr>
<tr><td>Metacognition for something else (e.g., maths achievement)
X
(Creativity)</td><td>Internally testing metacognition (e.g., solely measuring this or an aspect of it)</td><td>Testing the tool (e.g., assessing its reliability or validity)</td><td colspan="3">Extra info (if applicable)</td></tr>
<tr><td colspan="6">Type of study:</td></tr>
<tr><td>Pre/Post-test</td><td>Longitudinal</td><td>Experimental</td><td>Other
X</td><td>Unclear</td><td>Extra info</td></tr>
<tr><td colspan="3">Reliability:</td><td colspan="3">Validity:</td></tr>
<tr><td colspan="3"></td><td colspan="3"></td></tr>
<tr><td colspan="6">Administration (who administers measure/training required):
Teachers
Digital tablets to administer</td></tr>
<tr><td colspan="6">Strengths:
• Simple, easy to use tool.</td></tr>
<tr><td colspan="6">Weaknesses:
• Limitation in research design in that instrument has been tested with children from a single country with similar cultural and environmental influences – culture plays a significant role in creativity (Said-Metwaly et al., 2021).
• Measure of creativity is based on a single task.
• Metacognition aspect of tool not assessed for reliability or validity.</td></tr>
<tr><td colspan="2">Adaptions made to original instrument:</td><td colspan="4">Record:</td></tr>
<tr><td colspan="2">N/A</td><td colspan="4">N/A</td></tr>
<tr><td colspan="6">Related records: 0</td></tr>
</table>

Table 15: Creative metacognitive measure

<table>
<tr><td colspan="4">Name and type of instrument:
Creative metacognitive measure</td></tr>
<tr><td colspan="4">Aspect of metacognition measured:
Metacognitive knowledge and monitoring</td></tr>
<tr><td colspan="4">First record (full reference, must have detailed methods and details of reliability and validity):
Anderson, R. C., & Haney, M. (2021). Reflection in the Creative Process of Early Adolescents: The Mediating Roles of Creative Metacognition, Self-Efficacy, and Self-Concept. Psychology of Aesthetics, Creativity, and the Arts, 15(4), 612–626. https://doi.org/10.1037/aca0000324</td></tr>
<tr><td colspan="4">Definition of metacognition associated with original development measure:
Creative metacognition is ‘the combination of creative self-awareness, strategy, and contextual understanding’. Utilises much of Flavell’s (1979) definition.</td></tr>
<tr><td colspan="4">Aim of the study:
“... to describe the nature of creative self-beliefs and metacognition in early adolescence and test their relationships in the model of creative behaviour as agentic action”.</td></tr>
<tr><td colspan="4">Description of the tool or method:
Positioned within a wider study on the creative process students reflect on what worked well, why it worked and what could be improved.
Participants responded to the questions ‘(a) to think about their approach and describe what worked well and (b) to think about what they would do differently to make their creature more creative’. These were marked by raters on a scale from 0 (incomplete response) to 2 (complete response) relating to creative strategy selection, self-regulatory monitoring, self-awareness of strengths or weaknesses, and contextual knowledge about the challenge.
First study used to establish the assessment protocol.</td></tr>
<tr><td>Sample size:
n=245</td><td colspan="2">Age range and average age (if applicable):
Children aged 12 to 13 (Year 7)</td><td>Setting of the study:
School, USA</td></tr>
<tr><td colspan="4">Link to metacognition:</td></tr>
<tr><td>Metacognition for something else (e.g., maths achievement)</td><td>Internally testing metacognition (e.g., solely measuring this or an aspect of it)
X
Exploring how metacognition effects the creative process.</td><td>Testing the tool (e.g., assessing its reliability or validity)</td><td>Extra info (if applicable)</td></tr>
</table>

<table>
<tr><td colspan="6">Type of study:</td></tr>
<tr><td>Pre/Post-test</td><td>Longitudinal</td><td>Experimental</td><td>Other</td><td>Unclear</td><td>Extra info</td></tr>
<tr><td colspan="3">Reliability:</td><td colspan="3">Validity:</td></tr>
<tr><td colspan="3">Inter-rater reliability = 0.85

Composite reliability =.86</td><td colspan="3">Factor model

Construct validity (confirmatory factor analysis)</td></tr>
<tr><td colspan="6">Administration (who administers measure/training required):
Teachers</td></tr>
<tr><td colspan="6">Strengths:
---</td></tr>
<tr><td colspan="6">Weaknesses:
Broad reflection questions are not always suitable for coding.
Descriptive coding and analysis of metacognition was scored by a single rater meaning that inter-rater reliability scores only pertained to other elements of the study.
Reflection prompts used would present different difficulty levels for different students</td></tr>
<tr><td colspan="3">Adaptions made to original instrument:</td><td colspan="3">Record:</td></tr>
<tr><td colspan="3">N/A</td><td colspan="3"></td></tr>
<tr><td colspan="6">Related records: 1

Beach, P.T., Anderson, R.C., Jacovidis, J.N. & Chadwick, K.L. (2020). Making The Abstract Explicit: The Role of Metacognition in Teaching and Learning, https://www.inflexion.org/making-the-abstract-explicit-the-role-of-metacognition-in-teaching-and-learning/</td></tr>
</table>

Table 16: Evaluation and prediction Instrument

<table>
<tr><td colspan="6">Name and type of instrument:
Evaluation and prediction instrument (EPA2000)</td></tr>
<tr><td colspan="6">Aspect of metacognition measured:
Metacognitive monitoring</td></tr>
<tr><td colspan="6">First record (full reference, must have detailed methods and details of reliability and validity):
De Clercq, A., Desoete, A., & Roeyers, H. (2000). EPA2000: A multilingual, programmable computer assessment of off-line metacognition in children with mathematical-learning disabilities. Behavior Research Methods, Instruments, & Computers, 32, 304–311.</td></tr>
<tr><td colspan="6">Definition of metacognition associated with original development measure:
- “…awareness of one’s own cognitive functioning and the active monitoring of one’s own cognitive processes (Flavell, 1976; Verschaffel, 1999)” (p. 304).</td></tr>
<tr><td colspan="6">Aim of the study:
- To develop a program package for implementing a computerised instrument for metacognitive assessment.
- Although this instrument has been used with students with learning disabilities, authors also indicate that test can be used with children who perform moderately well (p. 305).</td></tr>
<tr><td colspan="6">Description of the tool or method:
• Children look at mathematical exercises without solving them and predict whether they would be successful using a 4-point colour rating scale (p. 305).</td></tr>
<tr><td colspan="2">Sample size:
n=104</td><td colspan="2">Age range and average age (if applicable):
Children aged 8 to 9 (Year 3)</td><td colspan="2">Setting of the study:
School, Belgium</td></tr>
<tr><td colspan="6">Link to metacognition:</td></tr>
<tr><td>Metacognition for something else (e.g., maths achievement)
X</td><td>Internally testing metacognition (e.g., solely measuring this or an aspect of it)
X</td><td>Testing the tool (e.g., assessing its reliability or validity)
X</td><td colspan="3">Extra info (if applicable)</td></tr>
<tr><td colspan="6">Type of study:</td></tr>
<tr><td>Pre/Post-test</td><td>Longitudinal</td><td>Experimental</td><td>Other
X</td><td>Unclear</td><td>Extra info</td></tr>
</table>

<table>
<tr><td colspan="2">Reliability:</td><td>Validity:</td></tr>
<tr><td colspan="2">Cronbach’s alpha used for reliability.</td><td>Different experts consulted to provide construct validity.

Concurrent validity – Pearson product-moment correlation coefficients computed.</td></tr>
<tr><td colspan="3">Administration (who administers measure/training required):
Teachers</td></tr>
<tr><td colspan="3">Strengths:
Simple instrument that could easily be used online to a wide range of students of various ages.
Rigorous validation of the original pencil and paper test using 584 students.</td></tr>
<tr><td colspan="3">Weaknesses:
Limited to a focus on judgements of learning.</td></tr>
<tr><td>Adaptions made to original instrument:</td><td colspan="2">Record:</td></tr>
<tr><td>N/A</td><td colspan="2">N/A</td></tr>
<tr><td colspan="3">Related records: 1

Desoete, A. (2009). Metacognitive Prediction and Evaluation Skills and Mathematical Learning in Third-Grade Students. Educational Research and Evaluation, 15(5), 435-446.</td></tr>
</table>

Table 17: Electronic portfolio tool

Name and type of instrument: Electronic portfolio tool (ePEARL)
Aspect of metacognition measured: Metacognitive knowledge, monitoring and control
First record (full reference, must have detailed methods and details of reliability and validity): Meyer, E., Abrami, P. C., Wade, C. A., Aslan, O., & Deault, L. (2010). Improving Literacy and Metacognition with Electronic Portfolios: Teaching and Learning with ePEARL. *Computers & Education, 55*(1), 84-91. doi:https://doi.org/10.1016/j.compedu.2009.12.005
Definition of metacognition associated with original development measure: "Metacognition refers to the awareness, knowledge and control of cognition. The three processes that make up metacognitive self- regulation are planning, monitoring, and regulating. Other aspects of self-regulated learning include time-management, regulating one's own physical and social environment, and the ability to control one's effort and attention" (p. 84).
Aim of the study: Develop and test and electronic portfolio.
Description of the tool or method: • A two group repeated measures design. • ePEARL is described as: "a bilingual (English-French) web-based, student-centred electronic portfolio software, that is designed to support the phases of self-regulation. The three cyclical phases of self-regulation include both metacognitive and motivational components, providing the foundation for better sustainability of learning and skill development. The forethought phase includes task analysis (goal setting and strategic planning) and self-motivation beliefs (self-efficacy, outcome expectations, intrinsic interest/value and goal orientation). Tasks involved in the forethought phase are: set outcome goals, set process goals, document goal values, plan strategies, and set up learning logs. The next phase, the performance phase, includes self-control (self-instruction, imagery, attention focusing and task strategies) and self-observation (self-recording and self-experimentation). Tasks involved in the performance phase are: creation of work and learning log entries. Finally, the self-reflection phase includes self-judgment (self-evaluation and casual attribution) and self-reaction (self-satisfaction/affect and adaptive-defensive responses) (Zimmerman, 2000). Tasks involved in the self-reflection phase are: reflection on work, reflection on process, and awareness of new goal opportunities" (p. 85). • Three levels of ePEARL have been designed for use in early elementary, late elementary and secondary schools. • Students collect their selected artifacts and place them into the presentations folder. ePEARL allows students to attach and compile work from other software. • SLSQ also applied to triangulate data: "The SLSQ contains several open-ended questions and 20 close-ended Likert scale questions designed to match the learning strategies questions asked of teachers. The SLSQ measures students' perception of their ability to employ SRL strategies including their ability to set learning goals, observe and correct

their performance and reflect on the learning outcome. Reliability and validity information are reported in the results" (p. 86).

Sample size:	Age range and average age (if applicable):	Setting of the study:
n=388	**Children in Years 4 and 6**	Urban and rural English school boards in Quebec, Manitoba and Alberta.

Link to metacognition:

Metacognition for something else (e.g., maths achievement)	Internally testing metacognition (e.g., solely measuring this or an aspect of it)	Testing the tool (e.g., assessing its reliability or validity)	Extra info (if applicable)
X (writing)	X	X	

Type of study:

Pre/Post-test	Longitudinal	Experimental	Other	Unclear	Extra info
		X (Contains a control group)			

Reliability:	Validity:
"Two raters analysed a random sample of each classroom's portfolios and independently assigned each classroom a rating of low, medium or high implementation based on the criteria outlined in the IAP. Raters achieved a reliability of .70 across classrooms and together determined the IAP scores for each of the experimental classrooms" (p. 87).	"… test validity was established by showing that grade levels who were known to have different levels of achievement did indeed have different mean scores on the same test" (p. 86).

Administration (who administers measure/training required):
Teachers through use of software

Strengths:

- Triangulation of results provides higher reliability.

Weaknesses:

- Validation of the instrument was weak.
- Very labour intensive.
- Hard to translate to younger grades.
- More a scaffold of self-regulated learning than a measurement of metacognition.

Adaptions made to original instrument:	Record:

N/A	N/A
Related records: 0	

Table 18 Journaling

<table>
<tr><td colspan="4">Name and type of instrument:
Journaling</td></tr>
<tr><td colspan="4">Aspect of metacognition measured:
Metacognitive control</td></tr>
<tr><td colspan="4">First record (full reference, must have detailed methods and details of reliability and validity):
Glogger, I., Schwonke, R., Holzäpfel, L., Nückles, M., & Renkl, A. (2012). Learning Strategies Assessed by Journal Writing: Prediction of Learning Outcomes by Quantity, Quality, and Combinations of Learning Strategies. Journal of Educational Psychology, 104(2), 452–468. https://doi.org/10.1037/a0026683</td></tr>
<tr><td colspan="4">Definition of metacognition associated with original development measure:
The regulation of cognitive strategies in task completion.</td></tr>
<tr><td colspan="4">Aim of the study:
Validate the instrument and compare how metacognition impacts achievement.</td></tr>
<tr><td colspan="4">Description of the tool or method:
First study had students write learning journals during mathematics. These were assessed for quality and quantity of cognitive and metacognitive strategies. Study 2 replicated the method in biology.
The quality of metacognition was rated on a 6-point scale ranging from 1 (very low quality) to 6 (very high quality).</td></tr>
<tr><td>Sample size:
Study 1, n=236
Study 2, n=144</td><td colspan="2">Age range and average age (if applicable):
Children aged 14 to 15 (Year 9)</td><td>Setting of the study:
Schools, Germany
Study 1, Mathematics classes
Study 2, Biology classes</td></tr>
<tr><td colspan="4">Link to metacognition:</td></tr>
<tr><td>Metacognition for something else (e.g., maths achievement)
X
Exploring how levels of metacognition impact achievement</td><td>Internally testing metacognition (e.g., solely measuring this or an aspect of it)</td><td>Testing the tool (e.g., assessing its reliability or validity)</td><td>Extra info (if applicable)</td></tr>
</table>

Type of study:					
Pre/Post-test	Longitudinal	Experimental X Repeat testing to validate instrument	Other	Unclear	Extra info

Reliability:	**Validity:**
Inter-rater reliability = .79	Exploratory cluster analysis (Ward procedure with squared Euclidian distances) Study 1 intercorrelation =.69 Study 2 intercorrelation =.64

Administration (who administers measure/training required):

Strengths:

- Fits the context of schools.

Weaknesses:

- Measured metacognitive use under favourable conditions so limited generalisability.
- Motivation is a confounding variable in the writing of journals.
- Labour intensive.
- Unlikely to be useful for younger students and those with limited literacy skills.

Adaptions made to original instrument:	**Record:**
N/A	N/A

Related records: 0

Table 19: Junior Metacognitive Awareness Inventory

<table>
<tr><td colspan="6">Name and type of instrument:
Junior Metacognitive Awareness Inventory (Jr MAI)</td></tr>
<tr><td colspan="6">Aspect of metacognition measured:
Metacognitive knowledge and control</td></tr>
<tr><td colspan="6">First record (full reference, must have detailed methods and details of reliability and validity):
Sperling, R. A., Howard, B. C., Miller, L. A., & Murphy, C. (2002). Measures of Children's Knowledge and Regulation of Cognition. Contemporary Educational Psychology, 27(1), 51–79. https://doi.org/10.1006/ceps.2001.1091</td></tr>
<tr><td colspan="6">Definition of metacognition associated with original development measure:
Uses Brown’s (1978) definition of metacognition as being knowledge of cognition and regulation of cognition.</td></tr>
<tr><td colspan="6">Aim of the study:
Establish a research instrument for measuring metacognition in students in year 3-9 derived from an adult instrument.</td></tr>
<tr><td colspan="6">Description of the tool or method:
Self-report questionnaire adapted from adult MAI by Schraw and Dennison (1994).
Jr MAI A = 12 item questionnaire with three responses (never, sometimes, always) for Grades 3-5.
Jr MAI B = 18 item questionnaire (same first 12) with 5-point Likert.</td></tr>
<tr><td>Sample size:
Study 1, n=344
Study 2, n=412</td><td colspan="2">Age range and average age (if applicable):
Children aged 7 to 15</td><td colspan="3">Setting of the study:
School, USA</td></tr>
<tr><td colspan="6">Link to metacognition:</td></tr>
<tr><td>Metacognition for something else (e.g., maths achievement)</td><td>Internally testing metacognition (e.g., solely measuring this or an aspect of it)</td><td>Testing the tool (e.g., assessing its reliability or validity)</td><td colspan="3">Extra info (if applicable)</td></tr>
<tr><td colspan="6">Type of study:</td></tr>
<tr><td>Pre/Post-test
X</td><td>Longitudinal</td><td>Experimental</td><td>Other</td><td>Unclear</td><td>Extra info</td></tr>
</table>

Reliability:	Validity:
Teacher rating and other test correlation.	Factor loading based on MAI Criterion validity Face validity

Administration (who administers measure/training required):
Teacher

Strengths:

- Adapted for younger students.
- Variations available.
- Limited number of responses needed.
- Developed from a highly used metacognitive instrument for adults.
- Used in multiple studies.

Weaknesses:

- Subject to social desirability bias and literacy limitations.

Adaptions made to original instrument:	Record:
N/A	N/A

Related records: 11

Acar, O. (2019). Investigation of the science achievement models for low and high achieving schools and gender differences in Turkey. *Journal of Research in Science Teaching*, 56(5), 649–675. https://doi.org/10.1002/tea.21517

Balta, E. (2018). The Relationships Among Writing Skills, Writing Anxiety and Metacognitive Awareness. *Journal of Education and Learning*, 7(3), 233. https://doi.org/10.5539/jel.v7n3p233

Beach, P.T., Anderson, R.C., Jacovidis, J.N. & Chadwick, K.L. (2020). Making The Abstract Explicit: The Role Of Metacognition In Teaching And Learning, https://www.inflexion.org/making-the-abstract-explicit-the-role-of-metacognition-in-teaching-and-learning/

Kirbulut, Z. D. (2014). Modeling the relationship between high school students' chemistry self-efficacy and metacognitive awareness. International Journal of Environmental and Science Education, 9(2), 177–196. https://doi.org/10.12973/ijese.2014.210a

Kruit, P. M., Oostdam, R. J., van den Berg, E., & Schuitema, J. A. (2018). Effects of Explicit Instruction on the Acquisition of Students' Science Inquiry Skills in Grades 5 and 6 of Primary Education. *International Journal of Science Education, 40*(4), 421-441. doi:https://doi.org/10.1080/09500693.2018.1428777

Lemberger, M. E., & Clemens, E. V. (2012). Connectedness and Self-Regulation as Constructs of the Student Success Skills Program in Inner-City African American Elementary School Students. Journal of Counseling and Development, 90(4), 450–458. https://doi.org/10.1002/j.1556-6676.2012.00056.x

Nieto-Márquez, N. L., Baldominos, A., & Pérez-Nieto, M. Ángel. (2020). Digital teaching materials and their relationship with the metacognitive skills of students in primary education. *Education Sciences*, 10(4), 113. https://doi.org/10.3390/educsci10040113

Ömer, A. (2022). Modelling of the relationships between students' grade-level, epistemic beliefs, metacognition, and science achievement in low and high - achieving schools, *Educational Studies*, DOI: 10.1080/03055698.2022.2122702

Saraç, S., & Karakelle, S. (2012). On-Line and Off-Line Assessment of Metacognition. *International Electronic Journal of Elementary Education, 4*(2), 301-315.

Schwartz, N. H., Andersen, C., Hong, N., Howard, B., & McGee, S. (2004). The Influence of Metacognitive Skills on Learners' Memory of Information in a Hypermedia Environment. *Journal of Educational Computing Research*, 31(1), 77–93. https://doi.org/10.2190/JE7W-VL6W-RNYF-RD4M

Sperling, R. A., Richmond, A. S., Ramsay, C. M., & Klapp, M. (2012). The Measurement and Predictive Ability of Metacognition in Middle School Learners. *Journal of Educational Research, 105*(1), 1-7. doi:https://doi.org/10.1080/00220671.2010.514690

Table 20: Metacognitive Attribution Assessment and Metacognitive Skills and Knowledge Assessment

Name and type of instrument:
Metacognitive Attribution Assessment (MAA)
Metacognitive Skills and Knowledge Assessment (MSA)

Aspect of metacognition measured:

Metacognitive knowledge, monitoring and control

First record (full reference, must have detailed methods and details of reliability and validity):

Desoete, A., Roeyers, H. & Buysse, A. (2001). Metacognition and mathematical problem solving in grade 3. *Journal of Learning Disabilities*, 34, 435-449.

Definition of metacognition associated with original development measure:

"*Metacognitive knowledge* has been described as the knowledge and the deeper understanding of cognitive processes and products (Flavell, 1976)" (p. 435).

"According to Brown (1980), executive control or *metacognitive skills* can be seen as the voluntary control people have over their own cognitive processes. A substantial amount of data has been accumulated on four metacognitive skills: prediction, planning, monitoring, and evaluation" (p. 435).

Aim of the study:

"The present study aims to contribute some data to the debate on whether there are two or three components within metacognition. In order to do so, we investigate whether some of the most used metacognitive parameters (declarative knowledge, conditional knowledge, procedural knowledge, prediction, planning, monitoring, evaluation, and attribution) can be combined into two (knowledge and skills) or three (knowledge, skills, and beliefs) supervariables on which young children differ" (p. 436).

Developed this study as research conducted into relationship between metacognition and mathematics usually conducted in older children or students with acquired disabilities such as brain injury and inconsistent results found in younger children (p. 436).

Description of the tool or method:

- "The MAA is a 13-item attribution rating scale based on the work of Carr and Jessup (1995). Children evaluate internal stable (e.g., ability), internal nonstable (e.g., effort), external stable (e.g., task characteristics). And external nonstable (e.g., luck) attributions as causes of hypothetical situations. The four alternatives (internal stable, internal nonstable, external stable, and external nonstable) are ranked on a 4-point scale according to perceived importance" (pp. 437-438).
- "The MSA was inspired by the work of Cross and Paris (1988), Myers and Paris (1978), Lucangeli and Cornoldi (1997), Lucangeli et al. (1998), and Montague (1997). The MSA assesses, without time limit, two metacognitive components (knowledge and skills) including seven metacognitive parameters (declarative, procedural, and conditional knowledge, and prediction, planning, monitoring, and evaluation skills)" (p. 438).

Sample size:	**Age range and average age (if applicable):**	**Setting of the study:**
n=165	Children aged 8 to 9 (Year 3)	Elementary schools, Belgium

Link to metacognition:

Metacognition for something else (e.g., maths achievement)	Internally testing metacognition (e.g., solely measuring this or an aspect of it)	Testing the tool (e.g., assessing its reliability or validity)	Extra info (if applicable)
X (mathematics)	X	X	

Type of study:

Pre/Post-test	Longitudinal	Experimental	Other	Unclear	Extra info
			X		

Reliability:	**Validity:**
Instruments tested in a pilot study (n=30) to determine usefulness for age group (8- to 9-year-olds) and sensitivity in measuring individual differences (p. 437). Analyses of pilot showed that students without reading problems could handle instruments well. Cronbach alpha applied, varying from .59 to .87 with test-retest correlations of .81 (p < .0005) and "interrater reliabilities for the metacognitive parameters varying between .98 and 1 (p < .0005) were found" (p. 437).	Different experts consulted in pilot study to increase the construct validity. Concurrent validity of the MSA examined using Cronbach alpha interreliability analysis conducted with the four metacognitive skill scores (MSA) and four MSA questionnaire scores as scale items – resulted in a Cronbach alpha of .70 (p. 441).

Administration (who administers measure/training required):
Teachers and SSOs

Strengths:

- No time limit for students to complete which may contribute to students feeling less pressured and allow for greater focus on the assessment itself.
- Tool can be used to differentiate between mathematical ability groups and between students without specific learning disabilities.
- Rigorous assessment of tools.

Weaknesses:

- Instruments rely on children being able to read the instructions.
- Unrestricted time allowance may make it difficult for teachers to administer without additional classroom support.

Adaptions made to original instrument:	Record:
MSA tool translated into Turkish.	Özsoy, G. (2011). An investigation of the relationship between metacognition and mathematics achievement. *Asia Pacific Education Review,* 12(2), 227-235. doi:10.1007/s12564-010-9129-6
MSA tool translated into Turkish.	Ozsoy, G., & Ataman, A. (2009). The effect of metacognitive strategy training on mathematical problem solving achievement. *International Electronic Journal of Elementary Education, 1*(2), 68-83.
Related records: 0	

Table 21: Metacognitive Awareness Inventory

Name and type of instrument: Metacognitive Awareness Inventory (MAI)					
Aspect of metacognition measured: Metacognitive knowledge and control					
First record (full reference, must have detailed methods and details of reliability and validity): Schraw, G., & Dennison, R. S. (1994). Assessing Metacognitive Awareness. *Contemporary Educational Psychology, 19*(4), 460–475. https://doi.org/10.1006/ceps.1994.1033					
Definition of metacognition associated with original development measure: 'The ability to reflect upon, understand and control one's learning' (p. 460). Two components include the knowledge about cognition (subprocesses = declarative knowledge, procedural knowledge and conditional knowledge) and the regulation of cognition (subprocesses = planning, information management strategies, comprehension monitoring, debugging strategies and evaluation).					
Aim of the study: Validate the tool.					
Description of the tool or method: • 52 item inventory to measure adults' metacognitive awareness. Classified into 8 subcomponents. Ratings made on a 100-point scale.					
Sample size: Experiment 1, n=197 Experiment 2, n=110	**Age range and average age (if applicable):** Undergraduate students		**Setting of the study:** University, USA		
Link to metacognition:					
Metacognition for something else (e.g., maths achievement)	Internally testing metacognition (e.g., solely measuring this or an aspect of it)	Testing the tool (e.g., assessing its reliability or validity) X	Extra info (if applicable)		
Type of study:					
Pre/Post-test X	Longitudinal	Experimental X	Other	Unclear	Extra info

<table>
<tr><td>Reliability:</td><td colspan="2">Validity:</td></tr>
<tr><td>Retest
Experiment 1 Cronbach’s alpha of .95
Experiment 2 Cronbach’s alpha of .93</td><td colspan="2">Factor analysis: Orthogonal and oblique produced six factor solutions with eigenvalues greater than one
Restricted factor analysis with similar results
Predictive validity assessed through four analyses – first similar to the first experiment, second compared MAI with pre-test judgements of monitoring ability, test performance and monitoring accuracy</td></tr>
<tr><td colspan="3">Administration (who administers measure/training required):</td></tr>
<tr><td colspan="3">Strengths:
Rigorous assessment of tool for reliability and validity.
Secondary school students (Years 10 to 12) would be familiar with the vocabulary used in the instrument.
Each question is coded for item being assessed, e.g., ‘M’ for monitoring, ‘PK’ for procedural knowledge, ‘DK’ for declarative knowledge etc.
General domain tool.</td></tr>
<tr><td colspan="3">Weaknesses:
Self-report measure – requires additional instruments to ascertain whether the strategies students report on using are accurate.</td></tr>
<tr><td>Adaptions made to original instrument:</td><td colspan="2">Record:</td></tr>
<tr><td>Translated into Turkish and tool adapted for use with high school students.</td><td colspan="2">Sungur, S., & Senler, B. (2009). An Analysis of Turkish High School Students' Metacognition and Motivation. Educational Research and Evaluation, 15(1), 45-62.</td></tr>
<tr><td>Tool adapted for use with children.</td><td colspan="2">Umino, A., & Dammeyer, J. (2016). Effects of a non-instructional prosocial intervention program on children’s metacognition skills and quality of life. International Journal of Educational Research, 78, 24–31. https://doi.org/10.1016/j.ijer.2016.05.004</td></tr>
</table>

Related records: 6

Atmatzidou, S., Demetriadis, S., & Nika, P. (2018). How Does the Degree of Guidance Support Students' Metacognitive and Problem Solving Skills in Educational Robotics? *Journal of Science Education and Technology*, 27(1), 70–85. https://doi.org/10.1007/s10956-017-9709-x

Çini, A., Malmberg, J., & Järvelä, S. (2023). How individual metacognitive awareness relates to situation-specific metacognitive interpretations of collaborative learning tasks. Educational Studies, 49(1), 54–75. https://doi.org/10.1080/03055698.2020.1834359

Lee, C. B. (2013). Examining Intentional Knowing Among Secondary School Students : Through the Lens of Metacognition. *The Asia-Pacific Education Researche*r, 22(1), 79–90. https://doi.org/10.1007/s40299-012-0028-y

Snyder, K. E., Nietfeld, J. L., & Linnenbrink-Garcia, L. (2005). Giftedness and Metacognition: A Short-Term Longitudinal Investigation of Metacognitive Monitoring in the Classroom. *Gifted Child Quarterly, 55*(3), 181-193. doi:https://doi.org/10.1177/0016986211412769

Van Velzen, J. (2013). Assessing High-School Students' Ability to Direct Their Learning. *Assessment in Education: Principles, Policy & Practice, 20*(2), 170-186. doi:https://doi.org/10.1080/0969594X.2012.736365

Zepeda, C. D., Richey, J. E., Ronevich, P., & Nokes-Malach, T. J. (2015). Direct Instruction of Metacognition Benefits Adolescent Science Learning, Transfer, and Motivation: An In Vivo Study. Journal of Educational Psychology, 107(4), 954–970. https://doi.org/10.1037/edu0000022

Table 22: Metacognitive Awareness of Reading Strategies Inventory

Name and type of instrument: Metacognitive Awareness of Reading Strategies Inventory (MARSI)					
Aspect of metacognition measured: Metacognitive knowledge and control					
First record (full reference, must have detailed methods and details of reliability and validity): Mokhtari, K., & Reichard, C. (2002). Assessing students' metacognitive awareness of reading strategies. *Journal of Educational Psychology, 94*(2), 249–259. https://doi.org/10.1037//0022-0663.94.2.249					
Definition of metacognition associated with original development measure: Monitoring and strategic cognitive choice in response to a task.					
Aim of the study: To develop and validate 6th to 12th graders awareness and perceived use of reading strategies.					
Description of the tool or method: • A 30-item self-report questionnaire with three factors – global reading strategies, problem solving strategies and support reading strategies					
Sample size: n=825	**Age range and average age (if applicable):** Children aged 11 to 18 (Years 6 to 12)		**Setting of the study:** Schools, USA		
Link to metacognition:					
Metacognition for something else (e.g., maths achievement)	Internally testing metacognition (e.g., solely measuring this or an aspect of it)	Testing the tool (e.g., assessing its reliability or validity)	Extra info (if applicable)		
Type of study:					
Pre/Post-test	Longitudinal	Experimental	Other	Unclear	Extra info

Reliability:	**Validity:**
Items included if their factor loadings were at least .30 or above. Reviewed by three raters. Retested after revisions on 443 students.	Construct validity with factor analysis (13 eigenvalues greater than 1). Second principal-axis factor analysis using three factors and oblique Harris-Kaiser rotation, repeated in the second group. Cronbach's alpha from .83-.93

Administration (who administers measure/training required):
Teachers

Strengths:

- Short self-report instrument which would not infringe too much on class time.
- Rigorous testing of tool.
- Useful for assessing and promoting learner awareness of underlying processes involved in reading.

Weaknesses:

- Tool relies on children's abilities to read and interpret questions.
- As it is a self-report instrument, cannot tell from the tool alone whether students actually engage in the strategies they report using.
- Needs to be used as a supplement for assessing reading comprehension strategies.

Adaptions made to original instrument:	**Record:**
N/A	N/A

Related records: 4

Davis, D. S., Huang, B., & Yi, T. (2017). Making Sense of Science Texts: A Mixed-Methods Examination of Predictors and Processes of Multiple-Text Comprehension. *Reading Research Quarterly, 52*(2), 227-252. doi:https://doi.org/10.1002/rrq.162

NSW Department of Education. (2020). Metacognition: a key to unlocking learning, https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiG-uHE3vj_AhUuZmwGHTPUBQkQFnoECAYQAQ&url=https%3A%2F%2Ffiles.eric.ed.gov%2Ffulltext%2FEJ1141767.pdf&usg=AOvVaw2fz5YOGvu_QoXPiOhjEcsF&opi=89978449

Onde, D., Jimenez, V., Alvarado, J. M., & Gracia, M. (2022). Analysis of the Structural Validity of the Reduced Version of Metacognitive Awareness of Reading Strategies Inventory. *Frontiers in Psychology*, 13, 894327–894327. https://doi.org/10.3389/fpsyg.2022.894327

Tamin, I.B., & Büyükahıska, D. (2020). Reading Strategy Instruction on Metacognitive Awareness: The Case of Turkish High School Students. *The Reading Matrix*, 20(2), 82.

Table 23: Mathematics, School and me

<table>
<tr><td colspan="6">Name and type of instrument:
Mathematics, School and Me</td></tr>
<tr><td colspan="6">Aspect of metacognition measured:
Metacognitive knowledge</td></tr>
<tr><td colspan="6">First record (full reference, must have detailed methods and details of reliability and validity):
Bednorz, D., & Bruhn, S. (2023). Influence of primary students' self-regulated learning profiles on their rating of a technology-enhanced learning environment for mathematics. Frontiers in Psychology, 14, 1074371–1074371. https://doi.org/10.3389/fpsyg.2023.1074371</td></tr>
<tr><td colspan="6">Definition of metacognition associated with original development measure:
Knowledge of how (procedural), when (conditional) and why (declarative) to use cognitive strategies.</td></tr>
<tr><td colspan="6">Aim of the study:
Explore how primary students' differences in their SRL and motivation affect their rating of the quality of mathematical technologically enhanced learning environments.</td></tr>
<tr><td colspan="6">Description of the tool or method:
• 15 item self-report questionnaire exploring repetition strategies, elaboration strategies and controlling strategies. Motivation and metacognitive strategies to learn in mathematics also explored. This was responded to using a 4-point Likert scale.</td></tr>
<tr><td>Sample size:
n=115</td><td colspan="2">Age range and average age (if applicable):
Children aged 8 to 11</td><td colspan="3">Setting of the study:
Five primary schools, online learner platform, Germany</td></tr>
<tr><td colspan="6">Link to metacognition:</td></tr>
<tr><td>Metacognition for something else (e.g., maths achievement)
X
(As a mediator to improvements in mathematics delivered by TELEs)</td><td>Internally testing metacognition (e.g., solely measuring this or an aspect of it)</td><td>Testing the tool (e.g., assessing its reliability or validity)</td><td colspan="3">Extra info (if applicable)</td></tr>
<tr><td colspan="6">Type of study:</td></tr>
<tr><td>Pre/Post-test</td><td>Longitudinal</td><td>Experimental</td><td>Other</td><td>Unclear</td><td>Extra info</td></tr>
</table>

Reliability:	Validity:
Cronbach's alpha of metacognition was .68	K means cluster analysis (assume that this does not measure the validity of the factors but only points to the validity of the three profiles they created)

Administration (who administers measure/training required):
Teachers

Strengths:

- Suitable for use with primary school students.
- Assesses mathematical motivation in mathematics.

Weaknesses:

- Time for and experience of teachers to evaluate technology enhanced learning environments (TELEs) from a pedagogical perspective to identify which learning opportunities for learning mathematics could be achieved with TELEs and which parts cannot be accomplished via this method.

Adaptions made to original instrument:	Record:
N/A	N/A

Related records: 0

Table 24: Metacognitive Baseline Questionnaire

Name and type of instrument: Metacognitive Baseline Questionnaire (MBQ)		
Aspect of metacognition measured: Metacognitive knowledge, monitoring and control		
First record (full reference, must have detailed methods and details of reliability and validity): Anderson, D., & Nashon, S. (2007). Predators of knowledge construction: Interpreting students' metacognition in an amusement park physics program. *Science Education*, 91, 298–320.		
Definition of metacognition associated with original development measure: "Metacognition is often described as active monitoring, conscious control, and regulation of learning processes (Baird, 1986; Baird & White, 1996; Flavel, 1987; Gunstone, 1994; Larkin, 2006; Mintzes & Wandersee, 1998; Thomas, 1999; Thomas & McRobbie, 2001; White, 1993, 1998)" (p. 299).		
Aim of the study: "This study aimed to elucidate the nature of students' metacognition and its influence on the knowledge construction process within the context of an amusement park physics program and within subsequent related classroom activities" (p. 301).		
Description of the tool or method: • 53 item questionnaire • Developed for determining individual metacognitive profiles on each of the six dimensions (p. 302). The six dimensions measured include: awareness, control, evaluation, planning, monitoring and self-efficacy. • instrument designed to assess students' self-reported engagement in metacognition learning situations within both formal and informal learning settings. • 53 items distributed across the six dimensions on a 5-point Likert scale. • "The 5-point scale required students to self-assess their degree of agreement with propositions conveyed in the MBQ items, i.e., 5—this statement is *always* or *almost always* true of me; 4—this statement is *frequently* true of me; 3—this statement is true of me about *half the time*; 2—this statement is *sometimes* true of me; 1—this statement is *never* or *only rarely* true of me" (p. 302).		
Sample size: n=40	**Age range and average age (if applicable):** Year 11	**Setting of the study:** School, British Columbia

Link to metacognition:

Metacognition for something else (e.g., maths achievement)	Internally testing metacognition (e.g., solely measuring this or an aspect of it)	Testing the tool (e.g., assessing its reliability or validity)	Extra info (if applicable)
X (Physics)	X	X	

Type of study:

Pre/Post-test	Longitudinal	Experimental	Other	Unclear	Extra info
			X (Pilot)		

Reliability:	**Validity:**
Cronbach alpha reliabilities were deemed to be within an acceptable range: "*control*, 0.798; *monitoring*, 0.717; *awareness*, 0.671; *evaluation*, 0.765; *planning*, 0.842; *self-efficacy,* 0.894" (p. 302).	Face validity: "The instrument was similarly reviewed by the same teachers and research partners to improve the face validity of the dimensions, the items, and the instrument in general" (p. 302).

Administration (who administers measure/training required):
Teachers

Strengths:

- Uses assessment tool in conjunction with an amusement park physics program - i.e., recognises the cross-contextual nature of learning.
-

Weaknesses:

- Small sample size for testing.

Adaptions made to original instrument:	**Record:**
N/A	N/A

Related records: 1

Nielsen, W. S., Nashon, S., & Anderson, D. (2009). Metacognitive Engagement during Field-Trip Experiences: A Case Study of Students in an Amusement Park Physics Program. *Journal of Research in Science Teaching, 46*(3), 265-288. doi:https://doi.org/10.1002/tea.20266

Table 25: Metacognition Applied to Physical Activity Scale

<table>
<tr><td colspan="6">Name and type of instrument:
Metacognition Applied to Physical Activity Scale</td></tr>
<tr><td colspan="6">Aspect of metacognition measured:
Metacognitive knowledge</td></tr>
<tr><td colspan="6">First record (full reference, must have detailed methods and details of reliability and validity):
Settanni, M., Magistro, D., & Rabaglietti, E. (2012). Development and Preliminary Validation of an Instrument to Measure Metacognition Applied to Physical Activity During Early Adolescence. Cognition, Brain, Behavior: an Interdisciplinary Journal, 16(1), 67.</td></tr>
<tr><td colspan="6">Definition of metacognition associated with original development measure:
“Metacognition represents the awareness that individuals have of their own cognitive abilities (and limitations) and of their and others' mental functioning; such awareness is developed in relation to different areas of learning such as linguistic, mathematical, emotional-affective, and physical activity areas” (p. 68).</td></tr>
<tr><td colspan="6">Aim of the study:
Exploring the influence of metacognition on physical activity through the validation of a new research instrument.</td></tr>
<tr><td colspan="6">Description of the tool or method:
• Questioning derived from an Italian paper (untranslated). Tool has 10 questions, and the students complete it an hour after their 2-hour PE lesson.</td></tr>
<tr><td>Sample size:
n=320</td><td colspan="2">Age range and average age (if applicable):
Children aged 11 to 15</td><td colspan="3">Setting of the study:
School, Italy, Physical Education lessons</td></tr>
<tr><td colspan="6">Link to metacognition:</td></tr>
<tr><td>Metacognition for something else (e.g., maths achievement)
X
(Metacognition as it relates to physical activity)</td><td>Internally testing metacognition (e.g., solely measuring this or an aspect of it)</td><td>Testing the tool (e.g., assessing its reliability or validity)
X</td><td colspan="3">Extra info (if applicable)</td></tr>
<tr><td colspan="6">Type of study:</td></tr>
<tr><td>Pre/Post-test</td><td>Longitudinal</td><td>Experimental</td><td>Other</td><td>Unclear</td><td>Extra info</td></tr>
</table>

<table>
<tr><th colspan="2">Reliability:</th><th colspan="2">Validity:</th></tr>
<tr><td colspan="2">Cronbach’s alpha</td><td colspan="2">Construct validity through exploratory factor analysis (χ^2(35, N = 320)

= 81.71, $p < .01$; RMSEA = .065; CFI = .98; SRMR = .048) and confirmatory factor analysis (χ^2(35, N = 320) =

75.814, $p < .01$; RMSEA = .061; CFI = .97)

Face validity

Content validity through expertise</td></tr>
<tr><td colspan="4">Administration (who administers measure/training required):
Teachers</td></tr>
<tr><td colspan="4">Strengths:
Content validity carefully assessed.
Instrument can be used across different sports without differentiating between individual and team sports.
The non-domain-specific design of the instrument allows for individuals with different physical activity experiences to be assessed.
Measures metacognition as applied to physical education – many tools are restricted to core curriculum areas of English, Mathematics and Science.
Domain specific which allows for an alternative to domain general instruments.</td></tr>
<tr><td colspan="4">Weaknesses:
Instrument uses a self-report measure so further tools are required in conjunction to understand if students are using the strategies they report to use.</td></tr>
<tr><td>Adaptions made to original instrument:</td><td colspan="3">Record:</td></tr>
<tr><td>N/A</td><td colspan="3">N/A</td></tr>
<tr><td colspan="4">Related records: 0</td></tr>
</table>

Table 26: Metacognitive Awareness Listening Questionnaire

Name and type of instrument: Metacognitive Awareness Listening Questionnaire					
Aspect of metacognition measured: Metacognitive knowledge and control					
First record (full reference, must have detailed methods and details of reliability and validity): Vandergrift, L., Goh, C.C.M., Mareschal, C.J. and Tafaghodtari, M.H. (2006), The Metacognitive Awareness Listening Questionnaire: Development and Validation. Language Learning, 56: 431-462. https://doi.org/10.1111/j.1467-9922.2006.00373.x					
Definition of metacognition associated with original development measure: Knowledge of cognitive states and processes and how to control them – based on Flavell's definition.					
Aim of the study: Develop and validate a listening questionnaire for second language listeners metacognitive awareness.					
Description of the tool or method: • 39 item questionnaire using a 6-point Likert scale (Strongly agree to strongly disagree) – provided in paper. This was administered after the class had been involved with an authentic listening activity					
Sample size: First year, n=966 Second year, n=512	**Age range and average age (if applicable):** High school to university and beyond	**Setting of the study:** Various countries and learning contexts			
Link to metacognition:					
Metacognition for something else (e.g., maths achievement)	Internally testing metacognition (e.g., solely measuring this or an aspect of it)	Testing the tool (e.g., assessing its reliability or validity) X	Extra info (if applicable)		
Type of study:					
Pre/Post-test	Longitudinal	Experimental	Other X (Validation of tool)	Unclear	Extra info

<table>
<tr><td>Reliability:</td><td>Validity:</td></tr>
<tr><td>Internal consistencies calculated with Cronbach’s alphas ranging from .68 to .78</td><td>Content validation through expert opinion and literature review

Exploratory factor analysis – Principal axis factor analysis resulted in 6 eigenvalues larger than 1

Confirmatory factor analysis</td></tr>
<tr><td colspan="2">Administration (who administers measure/training required):
Teacher</td></tr>
<tr><td colspan="2">Strengths:
• Large validation sample from wide sector of society.
• Easy to scale.</td></tr>
<tr><td colspan="2">Weaknesses:
• Quite domain specific.
• Probably unsuitable for younger students.</td></tr>
<tr><td>Adaptions made to original instrument:</td><td>Record:</td></tr>
<tr><td>N/A</td><td>N/A</td></tr>
<tr><td colspan="2">Related records: 1

Wallace, M. P. (2022). Individual Differences in Second Language Listening: Examining the Role of Knowledge, Metacognitive Awareness, Memory, and Attention. Language Learning, 72(1), 5–44. https://doi.org/10.1111/lang.12424</td></tr>
</table>

Table 27: Metacognitive Knowledge in Mathematics Questionnaire

<table>
<tr><td colspan="6">Name and type of instrument:
Metacognitive Knowledge in Mathematics Questionnaire</td></tr>
<tr><td colspan="6">Aspect of metacognition measured:
Metacognitive knowledge</td></tr>
<tr><td colspan="6">First record (full reference, must have detailed methods and details of reliability and validity):
Efklides, A., & Vlachopoulos, S. P. (2012). Measurement of metacognitive knowledge of self, task, and strategies in mathematics. European Journal of Psychological Assessment: Official Organ of the European Association of Psychological Assessment, 28(3), 227–239. https://doi.org/10.1027/1015-5759/a000145</td></tr>
<tr><td colspan="6">Definition of metacognition associated with original development measure:
Starts with Flavell’s definition but simplifies to knowledge of self, tasks and strategies.</td></tr>
<tr><td colspan="6">Aim of the study:</td></tr>
<tr><td colspan="6">Description of the tool or method:
Self-report questionnaire exploring metacognitive knowledge of self (2 subscales – easiness/fluency and difficulty/lack of fluency), tasks (2 subscales – easy/low demand and difficult/high demand) and strategies (3 subscales – cognitive/metacognitive strategies, competence-enhancing strategies and avoidance strategies).</td></tr>
<tr><td>Sample size:
n=311
(Validated on 214 university students)</td><td colspan="2">Age range and average age (if applicable):
Children aged 12 to 15 (Years 7 to 9)</td><td colspan="3">Setting of the study:
Schools, Greece</td></tr>
<tr><td colspan="6">Link to metacognition:</td></tr>
<tr><td>Metacognition for something else (e.g., maths achievement)</td><td>Internally testing metacognition (e.g., solely measuring this or an aspect of it)</td><td>Testing the tool (e.g., assessing its reliability or validity)</td><td colspan="3">Extra info (if applicable)</td></tr>
<tr><td colspan="6">Type of study:</td></tr>
<tr><td>Pre/Post-test</td><td>Longitudinal</td><td>Experimental</td><td>Other
X</td><td>Unclear</td><td>Extra info</td></tr>
</table>

Reliability:	Validity:
Test and retest	Confirmatory factor analysis Convergent validity to correlate the seven factors with measures of self-concept in mathematics Predictive validity using regression analysis Cronbach's αs for the seven factors were .74 for Easiness/Fluency, .76 for Difficulty/Lack of fluency, .90 for Easy/Low Demands Tasks, .81 for Difficult/High Demands Tasks, .85 for Cognitive/Metacognitive Strategies, .77 for Avoidance Strategies, and .70 for Competence-Enhancing Strategies.

Administration (who administers measure/training required):
Teachers

Strengths:

- Useful instrument for depicting students' beliefs about themselves as processors of mathematical tasks.
- Instrument differentiates metacognitive knowledge (Romuald) of the self from the MK of tasks and strategies.
- Rigorous testing of instrument.
- Can use with large groups of students at any one time.

Weaknesses:

- Self-report instrument – needs to be used in conjunction with other measures.

Adaptions made to original instrument:	Record:
N/A	N/A

Related records: 0

Table 28: Metacognitive Knowledge Interview

<table>
<tr><td colspan="7">Name and type of instrument:
Metacognitive Knowledge Interview</td></tr>
<tr><td colspan="7">Aspect of metacognition measured:
Metacognitive knowledge</td></tr>
<tr><td colspan="7">First record (full reference, must have detailed methods and details of reliability and validity):
Marulis, L.M., Palincsar, A.S., Berhenke, A.L. et al. (2016). Assessing metacognitive knowledge in 3–5 year olds: the development of a metacognitive knowledge interview (McKI). Metacognition Learning 11, 339–368 https://doi.org/10.1007/s11409-016-9157-7</td></tr>
<tr><td colspan="7">Definition of metacognition associated with original development measure:
Flavell’s definition of metacognition being the knowledge of people, tasks and strategies.</td></tr>
<tr><td colspan="7">Aim of the study:
Development of the tool</td></tr>
<tr><td colspan="7">Description of the tool or method:
Students completed challenging puzzles and then were interviewed on knowledge about people, tasks and strategies. Coding based on 0-2 (not at all metacognitive – appropriate metacognitive response).</td></tr>
<tr><td colspan="2">Sample size:
n=43</td><td colspan="2">Age range and average age (if applicable):
Children aged 3 to 5</td><td colspan="3">Setting of the study:
Preschool classrooms, USA</td></tr>
<tr><td colspan="7">Link to metacognition:</td></tr>
<tr><td>Metacognition for something else (e.g., maths achievement)</td><td colspan="2">Internally testing metacognition (e.g., solely measuring this or an aspect of it)</td><td>Testing the tool (e.g., assessing its reliability or validity)
X</td><td colspan="3">Extra info (if applicable)</td></tr>
<tr><td colspan="7">Type of study:</td></tr>
<tr><td>Pre/Post-test
X</td><td colspan="2">Longitudinal
X
(Over 4 sessions)</td><td>Experimental</td><td>Other</td><td>Unclear</td><td>Extra info</td></tr>
<tr><td colspan="4">Reliability:</td><td colspan="3">Validity:</td></tr>
<tr><td colspan="4">Test-retest correlation r.59, p=.001
Expert review of the questions</td><td colspan="3">Face validity since metacognitive knowledge increased over time.</td></tr>
</table>

Administration (who administers measure/training required): Teachers	
Strengths: • Suitable for younger year levels. • Interview is scripted and conducted in same manner.	
Weaknesses: • Puzzle tasks and interviews conducted individually – time consuming. Puzzle task requires approximately 15 minutes per student followed by interview of 10 to 25 minutes. • Requires extra staffing to support time in conducting interviews.	
Adaptions made to original instrument:	**Record:**
N/A	N/A
Related records: 1 NSW Department of Education (2020. *Metacognition: a key to unlocking learning*, https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiG-uHE3vj_AhUuZmwGHTPUBQkQFnoECAYQAQ&url=https%3A%2F%2Ffiles.eric.ed.gov%2Ffulltext%2FEJ1141767.pdf&usg=AOvVaw2fz5YOGvu_QoXPiOhjEcsF&opi=89978449	

Table 29: Metacognitive Knowledge Test

<table>
<tr><td colspan="3">Name and type of instrument:
Metacognitive Knowledge Test</td></tr>
<tr><td colspan="3">Aspect of metacognition measured:
Metacognitive knowledge</td></tr>
<tr><td colspan="3">First record (full reference, must have detailed methods and details of reliability and validity):
Haberkorn, K., Lockl, K., Pohl, S., Ebert, S., & Weinert, S. (2014). Metacognitive Knowledge in Children at Early Elementary School. Metacognition and Learning, 9(3), 239-263. doi:https://doi.org/10.1007/s11409-014-9115-1</td></tr>
<tr><td colspan="3">Definition of metacognition associated with original development measure:
“Within the broader construct of metacognition, metacognitive knowledge has been conceptualized as the declarative component besides children’s procedural activities in regulating and monitoring memory performance during a task (Flavell 1979; Schneider and Pressley 1997; Veenman et al. 2006)” (p. 240).</td></tr>
<tr><td colspan="3">Aim of the study:
“… to bridge the gap between research on early declarative metacognitive knowledge in preschool and studies on more elaborative metacognitive concepts at later elementary school” (p. 240).</td></tr>
<tr><td colspan="3">Description of the tool or method:
Testing lasts for about 15 minutes
“For each of the 15 tasks on metacognitive knowledge, a situation involving mental performance and three options were presented to the children. The test examiner read aloud the situations and the corresponding options and the children followed each approach by looking at the pictures in their test booklet. The examiner then asked the children which of the options presented they thought would be the best for performing a particular task. The children had to mark one out of the three options. Two of the options always showed two different ways of acting in the given situation or different conditions for mental performance. Children also had the possibility to choose the third option stating that the two presented alternatives work equally well. For each item, there was one option being the best with reference to the items of the previous studies mentioned above. Either one of the alternatives with differing strategic quality was better to act in the given scenario or the two alternatives were equally good. Children were rewarded with one point, if they chose the correct answer, otherwise, they got zero points” (p. 246).
Test contained in appendices as Table 5.</td></tr>
<tr><td>Sample size:
Round 1, n=870 (at end of Year 1)
Round 2, n=720 (at end of Year 2)</td><td>Age range and average age (if applicable):
Years 1 and 2</td><td>Setting of the study:
School, Germany</td></tr>
</table>

<table>
<tr><td colspan="6">Link to metacognition:</td></tr>
<tr><td>Metacognition for something else (e.g., maths achievement)</td><td>Internally testing metacognition (e.g., solely measuring this or an aspect of it)
X</td><td>Testing the tool (e.g., assessing its reliability or validity)
X</td><td colspan="3">Extra info (if applicable)</td></tr>
<tr><td colspan="6">Type of study:</td></tr>
<tr><td>Pre/Post-test</td><td>Longitudinal
X</td><td>Experimental</td><td>Other</td><td>Unclear</td><td>Extra info</td></tr>
<tr><td colspan="3">Reliability:</td><td colspan="3">Validity:</td></tr>
<tr><td colspan="3"></td><td colspan="3">Item response models used to evaluate the construct validity of the test.

Discriminant validity of the test investigated by correlating the metacognitive knowledge score with measures of language skills and cognitive nonverbal abilities (p. 248).</td></tr>
<tr><td colspan="6">Administration (who administers measure/training required):
Teachers and SSOs</td></tr>
<tr><td colspan="6">Strengths:
• Suitable for use in early primary years.
• Can be administered to small groups or a classroom of students at any one time.
• Test only takes 15 minutes to administer.</td></tr>
<tr><td colspan="6">Weaknesses:
• Relies on children’s abilities to interpret and process instructions.</td></tr>
<tr><td colspan="2">Adaptions made to original instrument:</td><td colspan="4">Record:</td></tr>
<tr><td colspan="2">N/A</td><td colspan="4">N/A</td></tr>
<tr><td colspan="6">Related records: 0</td></tr>
</table>

Table 30: Metacognitive Monitoring

<table>
<tr><td colspan="6">Name and type of instrument:
Metacognitive Monitoring</td></tr>
<tr><td colspan="6">Aspect of metacognition measured:
Metacognitive monitoring</td></tr>
<tr><td colspan="6">First record (full reference, must have detailed methods and details of reliability and validity):
Bellon, E., Fias, W., De Smedt, B. (2020). Metacognition across domains: Is the association between arithmetic and metacognitive monitoring domain-specific? PLoS ONE, 15(3): e0229932. https://doi.org/10.1371/journal.pone.0229932</td></tr>
<tr><td colspan="6">Definition of metacognition associated with original development measure:
Procedural metacognition where one's self reflects on performance.</td></tr>
<tr><td colspan="6">Aim of the study:
To investigate the degree to which metacognitive monitoring is domain specific (comparing mathematics to spelling).</td></tr>
<tr><td colspan="6">Description of the tool or method:
Children report their judgements of accuracy after completing each answer of a mathematics and spelling test (correct, incorrect, did not know). This was done within a computer program. Scoring based on responses correlating to performance (2), non-correlation (0) or saying they did not know (1).</td></tr>
<tr><td>Sample size:
Study 1, n=147
Study 2, n=77</td><td colspan="2">Age range and average age (if applicable):
Study 1, children aged 8 to 9
Study 2, children aged 7 to 8</td><td colspan="3">Setting of the study:
School, Belgium</td></tr>
<tr><td colspan="6">Link to metacognition:</td></tr>
<tr><td>Metacognition for something else (e.g., maths achievement)
X</td><td>Internally testing metacognition (e.g., solely measuring this or an aspect of it)</td><td>Testing the tool (e.g., assessing its reliability or validity)</td><td colspan="3">Extra info (if applicable)</td></tr>
<tr><td colspan="6">Type of study:</td></tr>
<tr><td>Pre/Post-test</td><td>Longitudinal</td><td>Experimental
X
(Quasi)</td><td>Other</td><td>Unclear</td><td>Extra info</td></tr>
</table>

Reliability:	Validity:
Cronbach's alpha for each of the items in regard to metacognitive monitoring. Found here: https://doi.org/10.1371/journal.pone.0229932.s002	Predictive (regression and correlation analysis)

Administration (who administers measure/training required):
Teachers or SSOs
Strengths: • Combines text with pictorial cues. • Administered through computer-based program.
Weaknesses: • **Self-report instrument –** use in conjunction with another measure to assess children's accuracy of reported strategies used.

Adaptions made to original instrument:	Record:
N/A	N/A

Related records: 0

Table 31: Metacognitive Self Regulation

Name and type of instrument: Metacognitive Self Regulation (MSR)					
Aspect of metacognition measured: Metacognitive knowledge					
First record (full reference, must have detailed methods and details of reliability and validity): Berger, J.-L., & Karabenick, S. A. (2016). Construct Validity of Self-Reported Metacognitive Learning Strategies. *Educational Assessment*, *21*(1), 19–33. https://doi.org/10.1080/10627197.2015.1127751					
Definition of metacognition associated with original development measure: Zimmerman's definition of forethought, monitoring and reflection.					
Aim of the study: Two research questions addressed in present study were: (a) How cognitively valid are items assessing metacognitive strategies? and (b) Does the item validity of items depend on the frequency of their use?					
Description of the tool or method: • Students completed the MSR; 15 participants with highest results and 15 with the lowest results were then interviewed. • MSR items from the MSLQ but related to maths and set to the three Zimmerman phases. • Self-report questionnaire of 13 items					
Sample size: n=306	**Age range and average age (if applicable):** Children aged 14 to 15 (Year 9)		**Setting of the study:** High school, USA, mathematics classes		
Link to metacognition:					
Metacognition for something else (e.g., maths achievement)	Internally testing metacognition (e.g., solely measuring this or an aspect of it)	Testing the tool (e.g., assessing its reliability or validity) X	Extra info (if applicable)		
Type of study:					
Pre/Post-test	Longitudinal	Experimental X (Quasi)	Other	Unclear	Extra info

<table>
<tr><td>Reliability:</td><td>Validity:</td></tr>
<tr><td>Iner-rater reliability (mean kappas were κ = .76 for interpretation, κ = .90 for elaboration and κ = .95 for answer choice)</td><td>Missing table but based on qualitative interview responses.</td></tr>
<tr><td colspan="2">Administration (who administers measure/training required):
Teachers</td></tr>
<tr><td colspan="2">Strengths:
• Test would be quite quick to administer in a classroom environment.</td></tr>
<tr><td colspan="2">Weaknesses:
• Self-report measure – requires additional tools to investigate whether strategies students report on are those they use.
• Two of the regulation items were incorrectly interpreted by 31% of the sample.</td></tr>
<tr><td>Adaptions made to original instrument:</td><td>Record:</td></tr>
<tr><td>N/A</td><td>N/A</td></tr>
<tr><td colspan="2">Related records: 0</td></tr>
</table>

Table 32: Metacognitive Knowledge - General

Name and type of instrument: Metacognitive Knowledge – general (MK-general)					
Aspect of metacognition measured: Metacognitive knowledge					
First record (full reference, must have detailed methods and details of reliability and validity): Neuenhaus, N., Artelt, C., Lingel, K., & Schneider, W. (2011). Fifth graders metacognitive knowledge: general or domain-specific? *European Journal of Psychology of Education, 26*(2), 163–178. https://doi.org/10.1007/s10212-010-0040-7					
Definition of metacognition associated with original development measure: Facilitation of effective learning strategy usage.					
Aim of the study: Investigate the structure of metacognitive knowledge in fifth grade pupils and its relation to school achievement.					
Description of the tool or method: • Participants assessed different strategies for their efficacy in developing effective learning.					
Sample size: n=763	**Age range and average age (if applicable):** Children aged 10 to 11 (Year 5)		**Setting of the study:** School, Germany		
Link to metacognition:					
Metacognition for something else (e.g., maths achievement) X (Relating general aspects of metacognition to mathematics and reading)	Internally testing metacognition (e.g., solely measuring this or an aspect of it)	Testing the tool (e.g., assessing its reliability or validity)	Extra info (if applicable)		
Type of study:					
Pre/Post-test	Longitudinal	Experimental	Other X	Unclear	Extra info

<table>
<tr><td colspan="2">Reliability:</td><td>Validity:</td></tr>
<tr><td colspan="2">Internal consistency</td><td>Construct validity
Utility</td></tr>
<tr><td colspan="3">Administration (who administers measure/training required):
Teachers</td></tr>
<tr><td colspan="3">Strengths:
• Study utilised a sample size sufficient for the analyses.
• Construct validity established through expert consultation.</td></tr>
<tr><td colspan="3">Weaknesses:
• The predictive power of metacognitive knowledge on students’ achievement in reading and mathematics was relatively low.</td></tr>
<tr><td>Adaptions made to original instrument:</td><td colspan="2">Record:</td></tr>
<tr><td>N/A</td><td colspan="2">N/A</td></tr>
<tr><td colspan="3">Related records: 0</td></tr>
</table>

Table 33: Metacognitive Knowledge - Reading

<table>
<tr><td colspan="6">Name and type of instrument:
Metacognitive Knowledge – reading (MK-reading); Metacognitive Knowledge – mathematics (MK-mathematics)</td></tr>
<tr><td colspan="6">Aspect of metacognition measured:
Metacognitive knowledge</td></tr>
<tr><td colspan="6">First record (full reference, must have detailed methods and details of reliability and validity):
Neuenhaus, N., Artelt, C., Lingel, K., & Schneider, W. (2011). Fifth graders metacognitive knowledge: general or domain-specific? European Journal of Psychology of Education, 26(2), 163–178. https://doi.org/10.1007/s10212-010-0040-7</td></tr>
<tr><td colspan="6">Definition of metacognition associated with original development measure:
Exploring conditional and relational metacognition within particular contexts.</td></tr>
<tr><td colspan="6">Aim of the study:
Investigate the structure of metacognitive knowledge in fifth grade pupils and its relation to school achievement.</td></tr>
<tr><td colspan="6">Description of the tool or method:
Participants assessed different strategies for their efficacy in solving particular domain specific problems.</td></tr>
<tr><td>Sample size:
n=763</td><td colspan="2">Age range and average age (if applicable):
Children aged 10 to 11</td><td colspan="3">Setting of the study:
Schools, Germany</td></tr>
<tr><td colspan="6">Link to metacognition:</td></tr>
<tr><td>Metacognition for something else (e.g., maths achievement)
X
(Relating general aspects of metacognition to maths and reading)</td><td>Internally testing metacognition (e.g., solely measuring this or an aspect of it)</td><td>Testing the tool (e.g., assessing its reliability or validity)</td><td colspan="3">Extra info (if applicable)</td></tr>
<tr><td colspan="6">Type of study:</td></tr>
<tr><td>Pre/Post-test</td><td>Longitudinal</td><td>Experimental</td><td>Other
X</td><td>Unclear</td><td>Extra info</td></tr>
</table>

Reliability:	**Validity:**
Internal consistency	Construct validity Utility

Administration (who administers measure/training required):
Teachers

Strengths:

- Study utilised a sample size sufficient for the analyses.
- Construct validity established through expert consultation.

Weaknesses:

- The predictive power of metacognitive knowledge on students' achievement in reading and mathematics was relatively low.

Adaptions made to original instrument:	**Record:**
N/A	N/A

Related records: 0

Table 34: Metacognitive Orientation Learning Environment Scale - Science

<table>
<tr><td colspan="4">Name and type of instrument:
Metacognitive Orientation Learning Environment Scale-Science (MOLE-S)</td></tr>
<tr><td colspan="4">Aspect of metacognition measured:
Metacognitive control</td></tr>
<tr><td colspan="4">First record (full reference, must have detailed methods and details of reliability and validity):
Alkin-Şahin, S. (2015). The extent to which the characteristics of a metacognitive oriented learning environment predict the characteristics of a thinking-friendly classroom. Eurasian Journal of Educational Research, 60, 241-260. doi:10.14689/ejer.2015.60.13</td></tr>
<tr><td colspan="4">Definition of metacognition associated with original development measure:
Refers to Flavell's definition as well as Livingston's (1997) 'thinking about thinking' definition (p. 242).</td></tr>
<tr><td colspan="4">Aim of the study:
To "… investigate the predictive relationships between the characteristics of a metacognitive oriented learning environment in science classes and the characteristics of a thinking-friendly classroom based on the opinions of secondary school students" (p. 241).</td></tr>
<tr><td colspan="4">Description of the tool or method:
Original instrument tested in China. This study has adapted original instrument by translating into Turkish.
MOLES-S includes 21 items aimed at eliciting how students perceive science classes in terms of their metacognitive orientation and what kinds of experiences they have regarding metacognition in science classes.
MOLES-S is comprised of five dimensions: emotional support, distributed control, student-student discourse, student voice, and metacognitive demands. The items in the scale are scored ranging from "1-Never to 5-Always."</td></tr>
<tr><td>Sample size:
n=378</td><td colspan="2">Age range and average age (if applicable):
Years 5 to 8</td><td>Setting of the study:
Schools, Turkey</td></tr>
<tr><td colspan="4">Link to metacognition:</td></tr>
<tr><td>Metacognition for something else (e.g., maths achievement)
X
(Science)</td><td>Internally testing metacognition (e.g., solely measuring this or an aspect of it)
X</td><td>Testing the tool (e.g., assessing its reliability or validity)
X</td><td>Extra info (if applicable)</td></tr>
</table>

Type of study:					
Pre/Post-test	Longitudinal	Experimental	Other X	Unclear	Extra info

Reliability:	**Validity:**
Reliability tested through Cronbach's Alpha coefficient and found to range from 0.57 to 0.87 for the sub-dimensions.	Construct validity tested with exploratory and confirmatory factor analysis (p. 245).

Administration (who administers measure/training required):
Teachers

Strengths:

- A domain specific tool suitable for use in science classrooms.
- Rigorous testing and assessment of tool.
- Relatively easy to administer.

Weaknesses:

- Self-report instrument – needs to be used in conjunction with other measures.

Adaptions made to original instrument:	**Record:**
N/A	N/A

Related records: 1

Peters, E., & Kitsantas, A. (2010). The Effect of Nature of Science Metacognitive Prompts on Science Students' Content and Nature of Science Knowledge, Metacognition, and Self-Regulatory Efficacy. *School Science and Mathematics, 110*(8), 382-396. doi:https://doi.org/10.1111/j.1949-8594.2010.00050.x

Table 35: Metacognitive Processes in Physical Education Questionnaire

<table>
<tr><td colspan="3">Name and type of instrument:
Metacognitive Processes in Physical Education Questionnaire (MPIPEQ)</td></tr>
<tr><td colspan="3">Aspect of metacognition measured:
Metacognitive Knowledge</td></tr>
<tr><td colspan="3">First record (full reference, must have detailed methods and details of reliability and validity):
Theodosiou, A., Mantis, K., & Papaioannou, A. (2008). Student Self-Reports of Metacognitive Activity in Physical Education Classes. Age-Group Differences and the Effect of Goal Orientations and Perceived Motivational Climate. Educational Research and Reviews, 3(12), 353-364.</td></tr>
<tr><td colspan="3">Definition of metacognition associated with original development measure:
'Prescribing metacognition as an individual's ability to know and control his/her cognitions, Flavell (1979) was the first who portrayed the two metacognition functions, that is, monitoring and regulatory function' (p. 353).</td></tr>
<tr><td colspan="3">Aim of the study:
Examine age-group differences in students' self-reports of metacognitive processes used during physical education lessons.</td></tr>
<tr><td colspan="3">Description of the tool or method:
"MPIPEQ was developed to measure students' metacognitive activity in physical education lessons" (p. 357).
"The scales that were used were designed to assess the eight factors mentioned by Brown (1987): 1. declarative knowledge (6 items: e.g., In the Physical Education class, I realize which exercises I can perform right), 2. procedural knowledge (5 items: e.g., ...the steps I have to follow in order to put in practice a good learning method I have been taught are clear to me), 3. conditional knowledge (6 items: e.g., ...when I want to grow better in a game I put into practice a learning strategy), 4. information management (6 items: e.g., ...I think if the exercise I am learning reminds me of another one I already know), 5. planning (4 items: e.g., ...it is clear for me what I want to learn), 6. self-monitoring (4 items: e.g., ...the moment I perform an exercise, I check if I actually learn it right), 7. problem solving strategies (7 items: e.g., ...when I make a mistake I stop and try again being more careful) and 8. evaluation (7 items: e.g., ...since I have learned an exercise I think if there was an easier way to succeed)" (p. 357).
Responses provided using a 5-point Likert scale.</td></tr>
<tr><td>Sample size:
n=510</td><td>Age range and average age (if applicable):
Years 5, 6, 8, 9, 11 and 12</td><td>Setting of the study:
Schools, Greece</td></tr>
</table>

Link to metacognition:			
Metacognition for something else (e.g., maths achievement) X (Physical education)	Internally testing metacognition (e.g., solely measuring this or an aspect of it) X	Testing the tool (e.g., assessing its reliability or validity) X	Extra info (if applicable)

Type of study:					
Pre/Post-test	Longitudinal	Experimental	Other X	Unclear	Extra info

Reliability:	**Validity:**
Cronbach alpha used to measure reliability.	

Administration (who administers measure/training required):
Teachers

Strengths:

- Provides an alternative to domain general instruments.
- Can be used across a wide range of year levels.
- Option to explore and monitor students' progress of metacognitive processes as they progress through their schooling.

Weaknesses:

- Self-report measure - requires additional tools to investigate whether strategies students report on are those they use.

Adaptions made to original instrument:	**Record:**
N/A	N/A

Related records: 0

Table 36: Metacomprehension Strategy Index

Name and type of instrument: Metacomprehension Strategy Index (Durai et al.)					
Aspect of metacognition measured: Metacognitive monitoring					
First record (full reference, must have detailed methods and details of reliability and validity): Schmitt, M. C. (1990). A Questionnaire to Measure Children's Awareness of Strategic Reading Processes. *The Reading Teacher*, *43*(7), 454–461.					
Definition of metacognition associated with original development measure: No definition provided.					
Aim of the study: To provide teachers with a tool to evaluate their students' awareness of metacomprehension strategies.					
Description of the tool or method: • A 25 item, 4 option, multiple choice questionnaire (p. 455). • Can be used before, during and after reading a narrative selection. • Can be administered by teacher by reading aloud to the students or have students read silently and answer questionnaire silently, author recommends the former. • Assesses students' awareness of metacomprehension behaviours within 6 broad categories: (a) predicting and verifying, (b) previewing, (c) purpose setting, (d) self questioning, (e) drawing from background knowledge and (f) summarising and applying fix-up strategies.					
Sample size: Not provided	**Age range and average age (if applicable):** Middle and senior secondary school students		**Setting of the study:** Schools, USA		
Link to metacognition:					
Metacognition for something else (e.g., maths achievement) X	Internally testing metacognition (e.g., solely measuring this or an aspect of it) X	Testing the tool (e.g., assessing its reliability or validity) X	Extra info (if applicable)		
Type of study:					
Pre/Post-test	Longitudinal	Experimental	Other	Unclear	Extra info

Reliability:	**Validity:**
Reports an internal consistency value of .87 using the Kuder-Richardson Formula 20 (Lonberger, 1988)	Face validity Convergent validity

Administration (who administers measure/training required):
Teachers and SSOs

Strengths:

- Relatively easy to administer.

Weaknesses:

- As it is a self-report instrument, cannot tell from instrument alone whether or not children actually perform the behaviours they claim to.
- Not recommended to use instrument in isolation.

Adaptions made to original instrument:	**Record:**
N/A	N/A

Related records: 1

Davis, D. S., Huang, B., & Yi, T. (2017). Making Sense of Science Texts: A Mixed-Methods Examination of Predictors and Processes of Multiple-Text Comprehension. *Reading Research Quarterly, 52*(2), 227-252. doi:https://doi.org/10.1002/rrq.162

Table 37: Motivated Strategies for Learning Questionnaire

<table>
<tr><td colspan="4">Name and type of instrument:
Motivated Strategies for Learning Questionnaire (MSLQ)</td></tr>
<tr><td colspan="4">Aspect of metacognition measured:
Metacognitive knowledge and control</td></tr>
<tr><td colspan="4">First record (full reference, must have detailed methods and details of reliability and validity):
Pintrich, P. R., & De Groot, E. V. (1990). Motivational and Self-Regulated Learning Components of Classroom Academic Performance. Journal of Educational Psychology, 82(1), 33–40. https://doi.org/10.1037/0022-0663.82.1.33</td></tr>
<tr><td colspan="4">Definition of metacognition associated with original development measure:
"… self-regulated learning includes students' metacognitive strategies for planning, monitoring, and modifying their cognition (e.g., Brown, Bransford, Campione, & Ferrara, 1983; Corno, 1986; Zim- merman & Pons, 1986, 1988)" (p. 34).</td></tr>
<tr><td colspan="4">Aim of the study:
Purpose of study was to "… examine and clarify the empirical relations between the motivational and self-regulated learning components … [and] examining the potential interactive relations of the three motivational components on self-regulated learning components. Finally, the relations between motivation, self-regulated learning, and student performance on classroom academic tasks were examined" (p. 34).</td></tr>
<tr><td colspan="4">Description of the tool or method:
Self-report questionnaire
Includes 56 items on student motivation, cognitive strategy use, metacognitive strategy use and management of effort (p. 34).
7-point Likert scale applied ranging from 1=not at all true of me to 7=very true of me in relation to their behaviour in either their science or English class.</td></tr>
<tr><td>Sample size:
n=173</td><td>Age range and average age (if applicable):
Children with a mean age of 12.5 (Year 7)</td><td colspan="2">Setting of the study:
Small city school in south-eastern Michigan. Drawn from eight science classrooms and seven English classrooms.</td></tr>
<tr><td colspan="4">Link to metacognition:</td></tr>
<tr><td>Metacognition for something else (e.g., maths achievement)
X</td><td>Internally testing metacognition (e.g., solely measuring this or an aspect of it)
X</td><td>Testing the tool (e.g., assessing its reliability or validity)</td><td>Extra info (if applicable)</td></tr>
</table>

<table>
<tr><td colspan="6">Type of study:</td></tr>
<tr><td>Pre/Post-test</td><td>Longitudinal</td><td>Experimental</td><td>Other
X</td><td>Unclear</td><td>Extra info</td></tr>
<tr><td colspan="3">Reliability:</td><td colspan="3">Validity:</td></tr>
<tr><td colspan="3"></td><td colspan="3">Authors note the ecological validity of instrument (p. 38).</td></tr>
<tr><td colspan="6">Administration (who administers measure/training required):
Teachers and SSOs</td></tr>
<tr><td colspan="6">Strengths:
• Commonly used due to its adaptability and ease of administration</td></tr>
<tr><td colspan="6">Weaknesses:
• Authors emphasise that self-reports, including this MSLQ, “… need to be replicated with other measures, such as think-aloud protocols, stimulated recall procedures, structured interviews, or behavioural measures” (p. 38).</td></tr>
<tr><td colspan="2">Adaptions made to original instrument:</td><td colspan="4">Record:</td></tr>
<tr><td colspan="2">Study determines the validity and reliability of the MSLQ for high school students (p. 829).</td><td colspan="4">Ilker, E., Arslan, Y., & Demirhan, G. A. (2014). Validity and Reliability Study of the Motivated Strategies for Learning Questionnaire. Educational Sciences: Theory & Practice., 14, 829–883.</td></tr>
<tr><td colspan="2">MSLQ translated into Turkish to be come ‘MSLQ-TR.’ Completed under supervision of two experts in English language (p. 110).</td><td colspan="4">Karadeniz, S., Buyukozturk, S., Akgun, O.E., Cakmak, E.K., & Demirel, F. (2008). The Turkish Adaptation Study of Motivated Strategies for Learning Questionnaire (MSLQ) for 12-18 Year Old Children: Results of Confirmatory Factor Analysis. TOJET the Turkish Online Journal of Educational Technology, 7(4).</td></tr>
<tr><td colspan="2">The original MSLQ instrument was translated into Spanish and adapted to electronic format (p. 4).</td><td colspan="4">Ortega-Torres, E., Joan-Josep, S.-P., & Sanjosé-López, V. (2020). Inter-Relations among Motivation, Self-Perceived Use of Strategies and Academic Achievement in Science: A Study with Spanish Secondary School Students. Sustainability, 12, 1-12. doi:https://doi.org/10.3390/su12176752</td></tr>
</table>

Related records: 9

Ahmed, W., van der Werf, G., Kuyper, H., & Minnaert, A. (2013). Emotions, Self-Regulated Learning, and Achievement in Mathematics: A Growth Curve Analysis. *Journal of Educational Psychology, 105*(1), 150-161. doi:https://doi.org/10.1037/a0030160

Alpaslan, M. M., Yalvac, B., Loving, C. C., & Willson, V. (2016). Exploring the relationship between high school students' physics-related personal epistemologies and self-regulated learning in Turkey. *International Journal of Science and Mathematics Education*, *14*, 297-317.

Haelermans, C. (2022). The Effects of Group Differentiation by Students' Learning Strategies. Instructional Science: An International Journal of the Learning Sciences, 50(2), 223-250.

Jacobse, A. E., & Harskamp, E. G. (2012). Towards Efficient Measurement of Metacognition in Mathematical Problem Solving. *Metacognition and Learning, 7*(2), 133-149. doi:https://doi.org/10.1007/s11409-012-9088-x

Kiran, D., & Sungur, S. (2012). Middle School Students' Science Self-Efficacy and Its Sources: Examination of Gender Difference. *Journal of Science Education and Technology, 21*(5), 619-630. doi:https://doi.org/10.1007/s10956-011-9351-y

Metallidou, P., & Vlachou, A. (2010). Children's Self-Regulated Learning Profile in Language and Mathematics: The Role of Task Value Beliefs. *Psychology in the Schools, 47*(8), 776-788. doi:https://doi.org/10.1002/pits.20503

Sungur, S. (2007). Modeling the relationships among students' motivational beliefs, metacognitive strategy use, and effort regulation. *Scandinavian Journal of Educational Research, 51*(3), 315-326. doi:10.1080/00313830701356166

Veenman, M.V.J., & van Cleef, D. (2019). Measuring metacognitive skills for mathematics: students' self-reports versus online assessment methods. *Research Papers in Education*, 27(5), 597-627.

Wolters, C. A. (2004). Advancing achievement goal theory: Using goal structures and goal orientations to predict students' motivation, cognition, and achievement. *Journal of educational psychology*, *96*(2), 236.

Table 38: Middle School Learning Strategies

Name and type of instrument: Middle School Learning Strategies (MSLS)		
Aspect of metacognition measured: Metacognitive knowledge		
First record (full reference, must have detailed methods and details of reliability and validity): Liu, O. L., Jackson, T., & Ling, G. (2008). An Initial Field Trial of an Instrument for Measuring Learning Strategies of Middle School Students. Research Report. ETS RR-08-03. *ETS Research Report Series*, 1-26.		
Definition of metacognition associated with original development measure: "Metacognitive strategies include activities that involve self-monitoring of the learning process, evaluation of learning strengths and weaknesses, and use of self-reflection at the end of the learning process (May 1994). The importance of metacognitive strategies is highlighted by their ability to enable learners to evaluate and adjust their own learning strategies accordingly (Oster, 2001)" (p. 2).		
Aim of the study: Purpose of study is to: "(a) devise a self-report instrument, the Middle School Learning Strategies (MSLS) scale, to help middle school students understand the learning skills and strategies they use in their knowledge inquiry process; and (b) collect validity evidence for the MSLS scale in terms of factor structure, reliability, and correlations to academic achievement" (p. 5).		
Description of the tool or method: • Study focuses on cognitive, behavioural and metacognitive strategies. • "Metacognitive strategies reflect the process of self-monitoring, checking, and reflection" (p. 6). • Designed the tool to align with students' academic activities. • 52 items from the MSLS measure were pilot tested. "These items were represented by two response formats. Some items asked for information regarding the frequency of student use of certain strategies, while others asked about the degree to which a student endorses the statement. For the former, the response categories included *hardly ever*, *sometimes*, *often*, and *almost always*. For the latter, the responses ranged from *strongly disagree*, *disagree*, *agree*, to *strongly agree*. All items were scored on a 4-point Likert scale" (p. 6).		
Sample size: n=238	**Age range and average age (if applicable):** Middle school students (Years 6 to 8)	**Setting of the study:** Three schools in the Princeton, New Jersey area, USA

Link to metacognition:			
Metacognition for something else (e.g., maths achievement)	Internally testing metacognition (e.g., solely measuring this or an aspect of it) X	Testing the tool (e.g., assessing its reliability or validity) X	Extra info (if applicable)

Type of study:					
Pre/Post-test	Longitudinal	Experimental	Other X (Field trial)	Unclear	Extra info

Reliability:	**Validity:**
Subscales of MSLS displayed a reasonable reliability ranging from 0.70 to 0.87 (p. i). "The reliability indicated by Cronbach's alpha was .87 for the effective strategies scale, .70 for the help seeking scale, and .79 for the bad habits scale. The three scales were moderately correlated; with the correlation coefficients in absolute value ranging from .28 to .47" (p. 13).	Face validity "To gather predictive validity information from the MSLS instrument, the scores on the scales were correlated with student self-report grades in language arts, math, science, and social studies" (p. 13). Authors note that additional validity could be developed by gathering additional data for triangulation.

Administration (who administers measure/training required):
Teachers

Strengths:
• Aligns with students' academic activities. • Can be used across several domains including languages, mathematics, science and HASS. • Supports identification of students' help-seeking behaviours. • Increases students' awareness about ineffective strategies and helps them recognise their learning strengths and weaknesses.

Weaknesses: • Sample primarily drawn from high socio-economically communities. Findings are not deemed generalisable to the wider population. **For instance, the authors note that '... parental educaiton may sub**stantially affect the degree of parental involvement and their ability to provide help and guidance to their children' (p. 15). • Students' self-reported grades were used as a criterion variable – school documented grades or teacher ratings would be a more reliable indicator.	
Adaptions made to original instrument:	**Record:**
N/A	N/A
Related records: 0	

Table 39: Metacognitive Support Questionnaire and Metacognitive Strategies Questionnaire

Name and type of instrument:

Contains two quantitative instruments: Metacognitive Support Questionnaire (MSpQ) and the Metacognitive Strategies Questionnaire (MStQ).

Aspect of metacognition measured:

Metacognitive knowledge and control

First record (full reference, must have detailed methods and details of reliability and validity):

Wagaba, F., Treagust, D. F., Chandrasegaran, A. L., & Won, M. (2016). Using Metacognitive Strategies in Teaching to Facilitate Understanding of Light Concepts among Year 9 Students. *Research in Science & Technological Education, 34*(3), 253-272. doi:https://doi.org/10.1080/02635143.2016.1144051

Definition of metacognition associated with original development measure:

"Metacognition involves awareness of one's thinking, active monitoring of cognitive processes, regulation of cognitive processes and application of heuristics to organise problem-solving. Metacognitive strategies are employed by a person in a process of purposeful inquiry (Schraw 2009)" (254).

Aim of the study:

"The study was designed to conduct and evaluate the effectiveness of a repertoire of interventions aimed at enhancing secondary school students' metacognitive capabilities and their achievements in science" (p. 253).

Description of the tool or method:

- "… the *Metacognitive Strategies Questionnaire* (*MStQ*), consisted of 28 items in three scales – Cognitive Strategy use (CSu), Self-Regulation (SR) and Cognitive Self-consciousness (CSC)" (p.
- The other questionnaire, the *Metacognitive Support Questionnaire* (*MSpQ*), consisted of 25 items in five scales – Student-Student Discourse (SSD), Student-Teacher Discourse (STD), Student Voice (Robbers et al.), Metacognitive Demand (MD) and Teacher Encouragement and Support (TES).

Sample size:	**Age range and average age (if applicable):**	**Setting of the study:**
n=35	Year 9	School, Australia

Link to metacognition:

Metacognition for something else (e.g., maths achievement)	Internally testing metacognition (e.g., solely measuring this or an aspect of it	Testing the tool (e.g., assessing its reliability or validity)	Extra info (if applicable)
X		X	

Type of study:					
Pre/Post-test	Longitudinal	Experimental	Other	Unclear	Extra info
X		X (Quasi)			

Reliability:	**Validity:**
Cronbach’s alpha reliability applied – results displayed in tables.	Only explores convergent validity between the qualitative and quantitative tools.

Administration (who administers measure/training required): Science teachers

Strengths:

- Instrument tested in an Australian context.
- Requires only 50 minutes to respond to both the pre-questionnaire and post-questionnaire.
- Provides an alternative to domain general tools.
- Links specifically to Australian Curriculum.

Weaknesses:

- Small sample size and only one class used for testing instrument.
- Domain specific.

Adaptions made to original instrument:	**Record:**
N/A	N/A

Related records: 1

Wagaba, F., Treagust, D. F., Chandrasegaran, A. L., & Won, M. (2016). An Action Research in Science: Providing Metacognitive Support to Year 9 Students. *International Journal of Environmental and Science Education, 11*(12), 5376-5395.

Table 40: Multiple Choice Questions

Name and type of instrument: Multiple Choice Questions (MKLP) (Note: unclear how acronym fits with the instrument name)
Aspect of metacognition measured: Metacognitive knowledge
First record (full reference, must have detailed methods and details of reliability and validity): Van Velzen, J. (2013). Assessing High-School Students' Ability to Direct Their Learning. *Assessment in Education: Principles, Policy & Practice, 20*(2), 170-186. doi:https://doi.org/10.1080/0969594X.2012.736365
Definition of metacognition associated with original development measure: No precise definition for metacognition offered, but the author states: "Theory on learning to learn emphasises that students who possess metacognitive knowledge of their learning processes can direct their own learning (Brown 1987; Cotterall 2009; Flavell 1979; Wenden 1998; White 1999)" (p. 170).
Aim of the study: To generate and examine possibilities of using "… multiple-choice questions in assessing untrained high-school students' degree of metacognitive knowledge of learning processes" (p. 171). Subsequent purpose: "… establish preliminary information about general learning and studying attitudes that relate to the assessment of metacognitive knowledge of learning processes" (p. 171).
Description of the tool or method: • Included 3 studies with different grade levels and instruments used. • First study: used the Metacognitive Awareness Inventory, checked feasibility of multiple-choice questions using five questions with component knowledge of cognitive knowledge (MKC), students then received a 10 self-report rating-scale questions about situational learning attitude (school learning) that included general questions of academic self-concept and of strategic management and were then finally presented with three open-ended questions about reflective thinking where answers were scored as 'wrong', 'descriptive' or 'explanative' (pp. 174-175). • Second study: 19 multiple-choice questions constructed (MKLP), 9 measuring cognitive knowledge, 3 for procedural knowledge, 5 for knowledge of task demands and five questions for metamemory (p. 176). • Third study: 2 versions of MKLP questions constructed to examine differences between grade 9 and 12 students. Grade 9 version consisted of 9 questions measuring cognitive knowledge and knowledge of task demands; grade 12 version consisted of 9 questions that also included metamemory questions (p. 179).

Sample size:	**Age range and average age (if applicable):**	**Setting of the study:**
Study 1, n=83 Study 2, n=164 Study 3, n=219	Study 1, Year 7 Study 2, Years 9 and 10 Study 3, Years 9 and 12	Suburban high schools, Netherlands Studies conducted during classroom lessons and for grade 12s, during mentor hours. Teachers instructed not to assist.

Link to metacognition:

Metacognition for something else (e.g., maths achievement)	Internally testing metacognition (e.g., solely measuring this or an aspect of it)	Testing the tool (e.g., assessing its reliability or validity)	Extra info (if applicable)
	X	X	

Type of study:

Pre/Post-test	Longitudinal	Experimental	Other	Unclear	Extra info
			X		

Reliability:	**Validity:**
Acceptable levels of reliability. Conducted factor analysis with factor loadings displayed in tables.	Face validity

Administration (who administers measure/training required):
Teachers

Strengths:

- Can be used across multiple year levels.
- Domain general instrument.

Weaknesses:

- Observations made by author about difficulties of assessing metacognitive knowledge: "… assessing students' metacognitive knowledge of learning processes, particularly regarding school-based purposes, yields three difficulties: (a) answering questions about metacognitive knowledge of learning processes can be flawed by unawareness and lack of verbal expressions; (b) unfamiliarity with these kind of questions can cause distress and, thereby, hinder answering; and (c) open-ended questions are not easy to score, which makes assessment for school-based purposes difficult" (p. 171).

Adaptions made to original instrument:	**Record:**
N/A	N/A

Related records: 0

Table 41: PISA 2009

<table>
<tr><td colspan="4">Name and type of instrument:
PISA 2009</td></tr>
<tr><td colspan="4">Aspect of metacognition measured:
Metacognitive knowledge and control</td></tr>
<tr><td colspan="4">First record (full reference, must have detailed methods and details of reliability and validity):
OECD. (2007). Reading framework for PISA 2009 (Draft 2). Princeton, NJ: OECD.</td></tr>
<tr><td colspan="4">Definition of metacognition associated with original development measure:
To develop '… an awareness and understanding of how one thinks and uses thinking strategies …' (p. 20).</td></tr>
<tr><td colspan="4">Aim of the study:
'… to determine the extent to which young people have acquired the wider knowledge and skills in reading, mathematics and science that they will need in adult life' (p. 12).</td></tr>
<tr><td colspan="4">Description of the tool or method:
"A number of reading scenarios (short vignettes) are presented to students. For each scenario, students are asked to evaluate the quality and usefulness of different reading and text comprehension strategies for reaching the intended goal" (p. 73).
"The rank order of strategies for each scenario is compared with an "optimal" rank order developed by experts in the field of text processing (reading researchers, teachers and educational psychologists). The correspondence between the rankings of experts and students is reflected in a metacognition score indicating the degree to which students are aware of the best ways of storing text information and understanding memory and comprehension goals. In order to achieve high scores on the metacognition test, students must activate knowledge about cognitive resources, the nature of the task, and strategies that facilitate understanding, remembering and recalling of information" (p. 73).</td></tr>
<tr><td>Sample size:
n=between 4500 and 10,000</td><td colspan="2">Age range and average age (if applicable):
Children aged 15</td><td>Setting of the study:
Schools, OECD countries</td></tr>
<tr><td colspan="4">Link to metacognition:</td></tr>
<tr><td>Metacognition for something else (e.g., maths achievement)
X
(Reading)</td><td>Internally testing metacognition (e.g., solely measuring this or an aspect of it)
X</td><td>Testing the tool (e.g., assessing its reliability or validity)</td><td>Extra info (if applicable)</td></tr>
</table>

<table>
<tr><td colspan="6">Type of study:</td></tr>
<tr><td>Pre/Post-test</td><td>Longitudinal</td><td>Experimental</td><td>Other
X</td><td>Unclear</td><td>Extra info</td></tr>
<tr><td colspan="3">Reliability:</td><td colspan="3">Validity:</td></tr>
<tr><td colspan="3"></td><td colspan="3"></td></tr>
<tr><td colspan="6">Administration (who administers measure/training required):
PISA and teachers</td></tr>
<tr><td colspan="6">Strengths:
• Large sample size for testing.
• Relevant for cross-cultural contexts.</td></tr>
<tr><td colspan="6">Weaknesses:
• Assessment of reliability and validity of instrument unavailable.
• Only suitable for 15-year-olds.</td></tr>
<tr><td colspan="2">Adaptions made to original instrument:</td><td colspan="4">Record:</td></tr>
<tr><td colspan="2">N/A</td><td colspan="4">N/A</td></tr>
<tr><td colspan="6">Related records: 2

Neuenhaus, N., Artelt, C., Schneider, W., & Lingel, K. (2018). Does Metacognitive Knowledge Mediate the Relation between Goal Orientations and Educational Achievement in Secondary School Students? Electronic Journal of Research in Educational Psychology, 16(44), 5-33. doi:https://doi.org/10.25115/ejrep.v16i44.1935

Zhou, J., He, J., & Lafontaine, D. (2020). Cross-Cultural Comparability and Validity of Metacognitive Knowledge in Reading in PISA 2009: A Comparison of Two Scoring Methods. Assessment in Education: Principles, Policy & Practice, 27, 635-654. doi:https://doi.org/10.1080/0969594X.2020.1828820</td></tr>
</table>

Table 42: Prospective Memory Task and Ongoing Task performance

Name and type of instrument: Prospective Memory task (PM) and Ongoing Task (OT) performance			
Aspect of metacognition measured: Metacognitive monitoring			
First record (full reference, must have detailed methods and details of reliability and validity): Cottini, M., Basso, D., Pieri, A., & Palladino, P. (2021). Metacognitive Monitoring and Control in Children's Prospective Memory. *Journal of Cognition and Development, 22*(4), 619-639. doi:https://doi.org/10.1080/15248372.2021.1916500			
Definition of metacognition associated with original development measure: Draws from Flavell's (1979) definition and then expands to include: "In procedural metacognition, a further distinction has been made between metacognitive monitoring and control (Nelson & Narens, 1990). The first refers to the ability to judge one's own cognitive performance, whereas the second refers to executive processes that permit use and application of cognitive operations to improve performance" (p. 621).			
Aim of the study: To "… investigate the development of metacognitive monitoring and control, and their relation, in children's PM" (p. 623).			
Description of the tool or method: • PM: "… assessed by means of a computerized 1-back WM picture classification task" (p. 625). • Adapted task length to each age group. • Task instructions provided in form of a story. • At the end of the task, children asked to judge their performance. • OT: "was divided into two blocks (see Figure 1b): one without PM task instructions and targets (single OT), and one with PM task instructions and targets (dual OT)" (p. 626).			
Sample size: n=86	**Age range and average age (if applicable):** Children aged 5 and 6, and 8 to 10	**Setting of the study:** Different public preschools and primary schools in northern Italy	
Link to metacognition:			
Metacognition for something else (e.g., maths achievement)	Internally testing metacognition (e.g., solely measuring this or an aspect of it) X	Testing the tool (e.g., assessing its reliability or validity)	Extra info (if applicable)

<table>
<tr><td colspan="6">Type of study:</td></tr>
<tr><td>Pre/Post-test</td><td>Longitudinal</td><td>Experimental</td><td>Other
X</td><td>Unclear</td><td>Extra info</td></tr>
<tr><td colspan="3">Reliability:</td><td colspan="3">Validity:</td></tr>
<tr><td colspan="3"></td><td colspan="3">Concurrent validity</td></tr>
<tr><td colspan="6">Administration (who administers measure/training required):
Teachers and SSOs</td></tr>
<tr><td colspan="6">Strengths:
• Adapatible for different age groups.
• Instructions are read out to children with a Likert scale characterised by five faces to measure children’s confidence judgments – removes issue of children’s abilities to read and interpret questions.</td></tr>
<tr><td colspan="6">Weaknesses:
• One-to-one testing required as administrator reads questions and answer options aloud with child required to answer question aloud prior to pressing the labelled key on the computer (p. 633). Although this may increase the validity of the confidence scale, it would be time consuming to administer.
• Younger children may be more inclined/biased towards selecting the happy face option than older children when giving confidence judgments.</td></tr>
<tr><td colspan="3">Adaptions made to original instrument:</td><td colspan="3">Record:</td></tr>
<tr><td colspan="3">N/A</td><td colspan="3">N/A</td></tr>
<tr><td colspan="6">Related records: 0</td></tr>
</table>

Table 43: Reasoning/Not Reasoning Task

Name and type of instrument:

Reasoning/Not Reasoning Task

Aspect of metacognition measured:

Metacognitive knowledge

First record (full reference, must have detailed methods and details of reliability and validity):

Amsterlaw, J. (2006). Children's Beliefs About Everyday Reasoning. *Child Development, 77*(2), 443–464. https://doi.org/10.1111/j.1467-8624.2006.00881.x

Definition of metacognition associated with original development measure:

Knowledge about the goals, strategies and demands of particular tasks

Aim of the study:

Explore children’s metacognition about everyday reasoning and how they distinguish reasoning from non-reasoning.

Description of the tool or method:

- Participants receive nine scenarios (3 reasoning, 3 shortcut problem solving, 3 automatic action). There was a picture of a child’s face. The participants were asked to respond to the following questions - (1) Was X thinking - yes or no?; (2) How much was he or she thinking - a whole lot, a medium amount, or not really thinking at all?; (3) How hard was he or she thinking - very hard, kind of hard, or not hard at all?; (4) How long did it take him or her - a long time, a medium amount of time, or no time at all?; (5) In that story, did X have some kind of problem to figure out? Did he or she really have one, kind of have one, or not have one at all?; and How smart was what he or she did - very smart, kind of smart, or not smart at all?
- The participants were also asked to explain their thinking.
- The responses were coded.

Sample size:	**Age range and average age (if applicable):**	**Setting of the study:**
n=60	Children aged 6 to 11	School, USA

Link to metacognition:

Metacognition for something else (e.g., maths achievement) X (Exploring metacognition within reasoning processes)	Internally testing metacognition (e.g., solely measuring this or an aspect of it)	Testing the tool (e.g., assessing its reliability or validity)	Extra info (if applicable)

<table>
<tr><td colspan="7">Type of study:</td></tr>
<tr><td>Pre/Post-test</td><td>Longitudinal</td><td colspan="2">Experimental
X
(Quasi)</td><td>Other</td><td>Unclear</td><td>Extra info</td></tr>
<tr><td colspan="4">Reliability:</td><td colspan="3">Validity:</td></tr>
<tr><td colspan="4">Inter-rater = .92</td><td colspan="3">Face validity</td></tr>
<tr><td colspan="7">Administration (who administers measure/training required):
Teachers and SSOs</td></tr>
<tr><td colspan="7">Strengths:
Pictorial cues suitable for use with younger age groups.</td></tr>
<tr><td colspan="7">Weaknesses:
Some questions rely on children’s abilities to interpret facial expressions.
Students need to be tested individually with each session taking 20-25 minutes.</td></tr>
<tr><td colspan="3">Adaptions made to original instrument:</td><td colspan="4">Record:</td></tr>
<tr><td colspan="3">N/A</td><td colspan="4">N/A</td></tr>
<tr><td colspan="7">Related records: 0</td></tr>
</table>

Table 44: Relative Approximate Number System Metacognition Task

<table>
<tr><td colspan="6">Name and type of instrument:
Relative Approximate Number System (ANS) Metacognition Task</td></tr>
<tr><td colspan="6">Aspect of metacognition measured:
Metacognitive monitoring</td></tr>
<tr><td colspan="6">First record (full reference, must have detailed methods and details of reliability and validity):
Baer, C., & Odic, D. (2020). The Relationship Between Children's Approximate Number Certainty and Symbolic Mathematics. Journal of Numerical Cognition, 6(1), 50-65. https://doi.org/10.5964/jnc.v6i1.220</td></tr>
<tr><td colspan="6">Definition of metacognition associated with original development measure:
Identifying appropriate strategies, evaluating how much effort one put towards a strategy and assess whether you have answered correctly.</td></tr>
<tr><td colspan="6">Aim of the study:
Explore the numerical metacognition that may be a factor in children's approximate number system.</td></tr>
<tr><td colspan="6">Description of the tool or method:
Conducted on a computer.
Participants choose an item they feel most confident in answering.
They are shown two screenshots of dot comparisons and they point to the one they are more certain about calculating whether there are more blue or yellow dots.</td></tr>
<tr><td>Sample size:
n=72</td><td colspan="2">Age range and average age (if applicable):
Children aged 4 to 6</td><td colspan="3">Setting of the study:
Sound attenuated room at the university (i.e. clinical), Canada</td></tr>
<tr><td colspan="6">Link to metacognition:</td></tr>
<tr><td>Metacognition for something else (e.g., maths achievement)
X
(Number certainty)</td><td>Internally testing metacognition (e.g., solely measuring this or an aspect of it)</td><td>Testing the tool (e.g., assessing its reliability or validity)</td><td colspan="3">Extra info (if applicable)</td></tr>
<tr><td colspan="6">Type of study:</td></tr>
<tr><td>Pre/Post-test</td><td>Longitudinal</td><td>Experimental
X</td><td>Other</td><td>Unclear</td><td>Extra info</td></tr>
<tr><td colspan="3">Reliability:</td><td colspan="3">Validity:</td></tr>
<tr><td colspan="3"></td><td colspan="3">Face validity</td></tr>
</table>

Administration (who administers measure/training required): Teachers	
Strengths: • Children receive pre-recorded positive and negative feedback from the computer for the dot comparison trial they selected.	
Weaknesses: • Authors report that study was conducted with predominantly Caucasian children. Replications across different contexts and populations are necessary to strengthen the conclusions. • The authors explain that the relative metacognition task may not accurately measure children's metacognitive sensibility. • Extrinsic rewards used to recruit participants with authors also noting that experimenters would occasionally provide feedback to children to stay engaged in the task.	
Adaptions made to original instrument:	**Record:**
N/A	N/A
Related records: 0	

Table 45: Science Meta Test

Name and type of instrument: Science Meta Test (SMT)
Aspect of metacognition measured: Metacognitive knowledge, monitoring and control
First record (full reference, must have detailed methods and details of reliability and validity): Kruit, P. M., Oostdam, R. J., van den Berg, E., & Schuitema, J. A. (2018). Assessing students' ability in performing scientific inquiry: instruments for measuring science skills in primary education. *Research in Science & Technological Education*, *36*(4), 413-439.
Definition of metacognition associated with original development measure: No clear definition provided
Aim of the study: The aim of the present study is to explore to what extent structuring assessments by distinguishing between underlying skills will improve convergence between tests, attain more validity by including all aspects of inquiry, and offer the possibility of obtaining diagnostic information on students' performance. The following research questions were addressed: 1. Can students' ability in performing scientific inquiry be measured in a reliable manner? 2. To what extent is the measurement of students' ability in performing scientific inquiry related to their general cognitive ability? 3. Can students' ability in performing scientific inquiry be validly measured by means of different assessment instruments? 4. To what extent do measurements on subskill and step level provide additional diagnostic information to the overall measurement of students' ability in performing scientific inquiry?
Description of the tool or method: The metacognitive self-report test – Science Meta Test (SMT) – was designed to measure metacognitive self-regulatory skills, including orientation/planning, monitoring, and evaluation (Schraw and Moshman 1995). In contrast to the more general Jr. MAI, items were constructed specifically to obtain information about the extent to which metacognitive skills are applied in the performance assessments (PAs). For example: 'While doing measurements, I continued to verify that I was following my plan'. Submitting the items to a small sample of students showed that no reading or comprehension problems occurred. The final version of the SMT consisted of 13 items with a three-point scale (not, a little, a lot).

Sample size:	**Age range and average age (if applicable):**	**Setting of the study:**
n=128	Years 5 and 6	Primary schools, Netherlands

<table>
<tr><td colspan="6">Link to metacognition:</td></tr>
<tr><td>Metacognition for something else (e.g., maths achievement)
X
(Science)</td><td>Internally testing metacognition (e.g., solely measuring this or an aspect of it)</td><td>Testing the tool (e.g., assessing its reliability or validity)
X</td><td colspan="3">Extra info (if applicable)</td></tr>
<tr><td colspan="6">Type of study:</td></tr>
<tr><td>Pre/Post-test</td><td>Longitudinal</td><td>Experimental</td><td>Other</td><td>Unclear</td><td>Extra info</td></tr>
<tr><td colspan="3">Reliability:</td><td colspan="3">Validity:</td></tr>
<tr><td colspan="3">Cronbach's alpha = 0.66</td><td colspan="3">Construct validity
Content validity
Convergent validity</td></tr>
<tr><td colspan="6">Administration (who administers measure/training required):
Teachers</td></tr>
<tr><td colspan="6">Strengths:
Suitable for primary school students who are novices in performing scientific inquiry.
Performance assessments can be embedded in science lessons as part of the instructional materials.
Topics contained in PAs (I.e., skateboard, bungee jump and hot chocolate) are suitable for age range.
Scoring rubric accompanies each PA.
SMT can be administered to groups of children at any one time.</td></tr>
<tr><td colspan="6">Weaknesses:
The metacognitive skills measured in the SMT indicate that they are more task-specific in nature than those obtained by measuring general metacognitive skills.</td></tr>
<tr><td colspan="3">Adaptions made to original instrument:</td><td colspan="3">Record:</td></tr>
<tr><td colspan="3">N/A</td><td colspan="3">N/A</td></tr>
<tr><td colspan="6">Related records: 1

Kruit, P. M., Oostdam, R. J., van den Berg, E., & Schuitema, J. A. (2018). Effects of Explicit Instruction on the Acquisition of Students' Science Inquiry Skills in Grades 5 and 6 of Primary Education. International Journal of Science Education, 40(4), 421-441. doi:https://doi.org/10.1080/09500693.2018.1428777</td></tr>
</table>

Table 46: Self Evaluation

Name and type of instrument:

Self-Evaluation

Aspect of metacognition measured:

Metacognitive monitoring

First record (full reference, must have detailed methods and details of reliability and validity):

Lenski, S., Elsner, S. & Großschedl, J. (2022). Comparing Construction and Study of Concept Maps – An Intervention Study on Learning Outcome, Self-Evaluation and Enjoyment Through Training and Learning. *Front. Educ*. *7*:892312. doi: 10.3389/feduc.2022.892312

Definition of metacognition associated with original development measure:

The accuracy of self-evaluation refers to the congruency of objective and subjective performance evaluation. Self-evaluation is conceptually placed within the frameworks of metacognition and self-regulation (see Flavell, 1979; Panadero, 2017). Both frameworks refer to abilities that include planning, monitoring and evaluating one's own learning processes (Schraw, 1998; Panadero, 2017). Metacognition emphasizes the observer's perspective and is described as "thinking about thinking" (Flavell, 1979). One's own thoughts become objects of thoughts themselves. Accuracy of self-evaluation is placed within the evaluation aspect of self-regulation and metacognition.

Aim of the study:

They investigated the effects of concept map trainings (CM-c training, CM-s training, control training) and concept map learning type (CM-c learning, CM-s learning) on cognitive (learning performance, concept map quality, cognitive load), metacognitive (accuracy of self-evaluation) and emotional aspects (enjoyment) through a direct comparison.

Description of the tool or method:

- Self-evaluation on students' concept map skills was measured with five statements; "I read the text thoroughly," "I used all the concept stickers," "I paid attention to the direction of the arrows.", "I labelled all the arrows." and "I understood connections between concepts." Students rated their agreement on a three-stepped emoticon-based scale (joyful, indifferent, sad smiley) according to den Elzen-Rump and Leutner (2007).

Sample size:	**Age range and average age (if applicable):**	**Setting of the study:**
n=167	Year 8	Schools, Germany

Link to metacognition:

Metacognition for something else (e.g., maths achievement)	Internally testing metacognition (e.g., solely measuring this or an aspect of it)	Testing the tool (e.g., assessing its reliability or validity)	Extra info (if applicable)
X (Concept maps)			

<table>
<tr><td colspan="6">Type of study:</td></tr>
<tr><td>Pre/Post-test
X</td><td>Longitudinal</td><td>Experimental</td><td>Other</td><td>Unclear</td><td>Extra info</td></tr>
<tr><td colspan="3">Reliability:</td><td colspan="3">Validity:</td></tr>
<tr><td colspan="3">They reported internal consistencies for self-evaluation for each subtopic (concept map1: Cronbach’sα= 0.68, concept map 2: Cronbach’s α= 0.77, concept map 3: Cronbach’s α= 0.76).</td><td colspan="3"></td></tr>
<tr><td colspan="6">Administration (who administers measure/training required):
Teachers
Recommended that teachers apply a preceding CM-c training in classrooms.</td></tr>
<tr><td colspan="6">Strengths:
• CM-c promotes elaborative thinking.
• Training in CM-c was found to lead to enhanced learning performance and concept map quality.</td></tr>
<tr><td colspan="6">Weaknesses:
• Reliability of the pretest was low.
• Authors note that as instrument was not designed for use with students in middle secondary years, test validity for the age group is not confirmed.</td></tr>
<tr><td colspan="3">Adaptions made to original instrument:</td><td colspan="3">Record:</td></tr>
<tr><td colspan="3">N/A</td><td colspan="3">N/A</td></tr>
<tr><td colspan="6">Related records: 0</td></tr>
</table>

Table 47: Self-Induced Self-Reflective Thinking

Name and type of instrument: Self-Induced Self-Reflective Thinking (SISRT)			
Aspect of metacognition measured: Metacognitive knowledge			
First record (full reference, must have detailed methods and details of reliability and validity): van Velzen, J. H. (2017). Measuring Senior High School Students' Self-Induced Self-Reflective Thinking. *Journal of Educational Research, 110*(5), 494-502. doi:https://doi.org/10.1080/00220671.2015.1129596			
Definition of metacognition associated with original development measure: 'Generally, metacognition is divided into metacognitive knowledge and the executive processes. Metacognitive knowl- edge is known to include an awareness and understanding of one's cognitive processes (Brown, 1987; Flavell, 1979; Pintrich, 2002)' (p. 495).			
Aim of the study: 'The purpose of these two studies was to examine the legitimation of a relatively short measurement instrument that consisted of three open-ended questions' (p. 494).			
Description of the tool or method: • 'Three open-ended SISRT questions were used to enable the participants to write down a response in their own words by stating what they knew about SISRT. The three questions followed the process of reflection (Boud et al., 1985; Moon, 1999), which begins with reconsidering one's understanding by obtaining an overview of the situation. Accordingly, the focus is on the essential features of the situation. Finally, critical evaluation of the situation is taking place to establish improvements' (p. 496). • '… the first SISRT question referred to analysing or the obtaining of a general understanding and interpretation of learning experiences. The second SISRT question referred to the evaluation of essential features or outcomes of learning experiences. Finally, the third SISRT question referred to the critical evaluation or the synthesizing of information from learning experiences (pp. 496-497)'. • Two studies conducted, but only Study 2 used the SISRT instrument.			
Sample size: n=125	**Age range and average age (if applicable):** Children with a median age of 15 (Year 9)		**Setting of the study:** Six high schools, Netherlands
Link to metacognition:			
Metacognition for something else (e.g., maths achievement)	Internally testing metacognition (e.g., solely measuring this or an aspect of it) X	Testing the tool (e.g., assessing its reliability or validity) X	Extra info (if applicable)

Type of study:					
Pre/Post-test	Longitudinal	Experimental	Other X	Unclear	Extra info

Reliability:	**Validity:**
Intercoder reliability established which resulted in a reliability of *k*=.74	Nomological validity (p. 497)

Administration (who administers measure/training required):
Teacher or SSO

Strengths:

- Quick to administer as it only contains three questions.

Weaknesses:

- The SISRT contains three open-ended questions which makes it difficult to develop a comparable measure of students' metacognitive knowledge.

Adaptions made to original instrument:	**Record:**
N/A	N/A

Related records: 0

Table 48: Swanson Metacognitive Questionnaire

Name and type of instrument: Swanson Metacognitive Questionnaire (MSQ)			
Aspect of metacognition measured: Metacognitive knowledge			
First record (full reference, must have detailed methods and details of reliability and validity): Swanson, H. L. (1990). Influence of Metacognitive Knowledge and Aptitude on Problem Solving. *Journal of Educational Psychology*, *82*(2), 306–314. https://doi.org/10.1037/0022-0663.82.2.306			
Definition of metacognition associated with original development measure: 'Metacognition is defined as the knowledge and control one has over one's thinking and learning activities (e.g., Brown, Bransford, Ferrara, & Campione,1983; Flavell, 1978; Jacobs & Paris, 1987)' (p. 306).			
Aim of the study: "… the purpose of this study was to determine the independence of metacognition and general aptitude on various problem-solving measures" (p. 306).			
Description of the tool or method: • Children individually presented with a questionnaire containing 17 items. • Responses were tape-recorded. • Coding criterion established for each item. • Data from questionnaires scored according to five response categories ranked 1 to 5 according to metacognitive awareness. • Probes were used to clarify confusing answers, e.g., "tell me more …" • Highest score possible was 75. • 'Smartness' used in place of 'problem-solving' as children in this age range were found to associate someone who is good at problem-solving as being smart.			
Sample size: n=60	**Age range and average age (if applicable):** Years 4 and 5		**Setting of the study:** Four elementary schools, Canada
Link to metacognition:			
Metacognition for something else (e.g., maths achievement)	Internally testing metacognition (e.g., solely measuring this or an aspect of it) X	Testing the tool (e.g., assessing its reliability or validity) X	Extra info (if applicable)

<table>
<tr><td colspan="6">Type of study:</td></tr>
<tr><td>Pre/Post-test</td><td>Longitudinal
X</td><td>Experimental
X</td><td>Other</td><td>Unclear</td><td>Extra info</td></tr>
<tr><td colspan="3">Reliability:</td><td colspan="3">Validity:</td></tr>
<tr><td colspan="3">Interrater reliability established with each item above 90% and internal consistency (Cronbach alpha) was .87</td><td colspan="3"></td></tr>
<tr><td colspan="6">Administration (who administers measure/training required):
Teachers – would require further support to administer due to the individual nature of the instrument</td></tr>
<tr><td colspan="6">Strengths:
• Suitable for younger year levels.
• Utilises verbalisation of instrument rather than relying on students' abilities to read and comprehend questions.</td></tr>
<tr><td colspan="6">Weaknesses:
• Significant time involved for recording, coding and analysing data.
• Instrument needs to be administered individually where each students' responses are audio recorded and then coded – requires a significant degree of time.
• Not suitable for capturing large data sets.</td></tr>
<tr><td colspan="2">Adaptions made to original instrument:</td><td colspan="4">Record:</td></tr>
<tr><td colspan="2">N/A</td><td colspan="4">N/A</td></tr>
<tr><td colspan="6">Related records: 1

Sperling, R. A., Richmond, A. S., Ramsay, C. M., & Klapp, M. (2012). The Measurement and Predictive Ability of Metacognition in Middle School Learners. Journal of Educational Research, 105(1), 1-7. doi:https://doi.org/10.1080/00220671.2010.514690</td></tr>
</table>

Table 49: Systematical Observation

Name and type of instrument: Systematical Observation (SO)
Aspect of metacognition measured: Metacognitive control
First record (full reference, must have detailed methods and details of reliability and validity): Veenman, M. V., Kok, R., & Blöte, A. W. (2005). The relation between intellectual and metacognitive skills in early adolescence. *Instructional Science*, *33*, 193-211.
Definition of metacognition associated with original development measure: Metacognitive skilfulness often is distinguished from metacognitive knowledge (Alexander et al., 1995; Baker, 1994; Kuhn, 1999; Schraw & Moshman, 1995; Veenman & Elshout, 1999). The latter concept refers to the declarative knowledge one has about the interplay between personal characteristics, task characteristics and the available strategies in a learning situation (Flavell, 1979). Metacognitive knowledge, however, does not automatically lead to appropriate execution of metacognitive skills.
Aim of the study: The first research question in the present study is whether the mixed model applies to younger students who are still in the process of acquiring a vast repertoire of metacognitive skills. A second research question addresses the impact of giving metacognitive cues or hints as a 'reminder'.
Description of the tool or method: • Metacognitive skilfulness was assessed through systematical observation (SO) during the problem solving process (Veenman et al., 2000). All participants were instructed to 'think aloud' while individually solving the six math problems. The experimenter only urged them to continue thinking aloud whenever they fell silent with a standard instruction: 'Please, keep on thinking aloud'. No help whatsoever was provided for by the experimenter. From research (Ericsson & Simon,1980, 1984; Veenman et al., 1993) it is known that merely thinking aloud does not interfere with cognitive and metacognitive processes. Thinking aloud may only slow down those processes. For each problem, the experimenter concurrently scored the subject's metacognitive behaviour (SO) on the presence of 15 activities: • 1) entirely reading the problem statement (as incomplete task analysis leads to trial-and-error behaviour); (2) selection of relevant data (task analysis); (3) paraphrasing of what was asked for (task analysis and goal setting); (4) making a drawing related to the problem (task analysis);(5) estimating a possible outcome (goal setting);(Irct20140416017301N) designing an action plan before actually calculating (planning); (7) systematically carrying out such plan (to avoid haphazard behaviour); (8) calculation correctness (avoid sloppiness);(Irct20201107049293N) avoiding negligent mistakes (such as inattentively switching numbers); (Irct20201107049293N) orderly note-taking of problem solving steps (in order to keep an overview of problem-solving steps and create an opportunity for checking outcomes); (Irct20201107049293N) monitoring the on-going process;(12) checking the answer; (13) drawing a conclusion (recapitulating); (Irct20140416017301N) reflecting on the answer (referring to the problem statement);

(15) relating to earlier problems solved (reflection with the aim to learn from one's experiences).					
Sample size: n=41	**Age range and average age (if applicable):** Children aged 12-13 years old	**Setting of the study:** Clinical, Netherlands			
Link to metacognition:					
Metacognition for something else (e.g., maths achievement) X (Metacognitive skilfulness during mathematics exercises)	Internally testing metacognition (e.g., solely measuring this or an aspect of it)	Testing the tool (e.g., assessing its reliability or validity)	Extra info (if applicable)		
Type of study:					
Pre/Post-test	Longitudinal	Experimental	Other	Unclear	Extra info
Reliability:			**Validity:**		
			'In order to validate SO measurements, the thinking-aloud protocols of six participants were transcribed and subsequently analysed on the quality of metacognitive skilfulness (PA), using the judgmental procedure of Veenman and Elshout (1991, 1995, 1999) and Veenman et al. (1994, 1997, 2000). This judgmental procedure is not only based on the mere presence of metacognitive activity, but it also accounts for the quality of executed metacognitive activities' (p. 201). Convergent validity established (r=0.78, N=30) (p. 202)		
Administration (who administers measure/training required): Teachers					
Strengths: • Use of think aloud protocols means decreases reliance upon students' reading abilities.					

Weaknesses: • Requires participants to think-aloud during problem-solving process which requires instrument to be administered individually. • Think aloud protocols were transcribed and analysed – too time consuming in a school environment.	
Adaptions made to original instrument:	**Record:**
N/A	N/A
Related records: 0	

Table 50: Think Aloud Protocols

<table>
<tr><td colspan="6">Name and type of instrument:
Think Aloud Protocols</td></tr>
<tr><td colspan="6">Aspect of metacognition measured:
Metacognitive control</td></tr>
<tr><td colspan="6">First record (full reference, must have detailed methods and details of reliability and validity):
Deekens, V. M., Greene, J. A., & Lobczowski, N. G. (2018). Monitoring and depth of strategy use in computer-based learning environments for science and history. British Journal of Educational Psychology, 88(1), 63–79. https://doi.org/10.1111/bjep.12174</td></tr>
<tr><td colspan="6">Definition of metacognition associated with original development measure:
No definition provided</td></tr>
<tr><td colspan="6">Aim of the study:
Explore the use of deep and shallow strategies when using hypermedia sources (offline) to source and write about history information.</td></tr>
<tr><td colspan="6">Description of the tool or method:
After completing a pre-test of the topic students thought out loud as they wrote down information about the regulator movement. Trained researcher assistants coded these verbalisations.</td></tr>
<tr><td>Sample size:
n=40</td><td colspan="2">Age range and average age (if applicable):
Children aged 16</td><td colspan="3">Setting of the study:
School, USA</td></tr>
<tr><td colspan="6">Link to metacognition:</td></tr>
<tr><td>Metacognition for something else (e.g., maths achievement)</td><td>Internally testing metacognition (e.g., solely measuring this or an aspect of it)</td><td>Testing the tool (e.g., assessing its reliability or validity)</td><td colspan="3">Extra info (if applicable)</td></tr>
<tr><td colspan="6">Type of study:</td></tr>
<tr><td>Pre/Post-test
X</td><td>Longitudinal</td><td>Experimental</td><td>Other
X
(Exploring the thinking whilst doing a task)</td><td>Unclear</td><td>Extra info</td></tr>
</table>

Reliability:	Validity:
	Comparative fit index of 1

Administration (who administers measure/training required):
Teachers

Strengths:

- Provides an alternative to domain general instruments by being specific to computer-based learning environments in history and science.

Weaknesses:

- Small sample size used for testing.
- Think aloud protocols need to be transcribed and analysed – time consuming for a school environment.
- Instrument is task specific.

Adaptions made to original instrument:	Record:
N/A	NA

Related records: 0

Table 51: Train Track Task

<table>
<tr><td colspan="4">Name and type of instrument:
Train Track Task</td></tr>
<tr><td colspan="4">Aspect of metacognition measured:
Metacognitive monitoring and control</td></tr>
<tr><td colspan="4">First record (full reference, must have detailed methods and details of reliability and validity):
Bryce, D., Whitebread, D. (2012). The development of metacognitive skills: evidence from observational analysis of young children’s behaviour during problem-solving. Metacognition Learning 7, 197–217 https://doi.org/10.1007/s11409-012-9091-2</td></tr>
<tr><td colspan="4">Definition of metacognition associated with original development measure:
The ability to monitor and control their cognition on task.</td></tr>
<tr><td colspan="4">Aim of the study:
The exploration of how metacognitive skills develop in young children.</td></tr>
<tr><td colspan="4">Description of the tool or method:
Children had verbalisations and non-verbal behaviours coded for metacognitive strategy use whilst completing a task involving train tracks. Coding schemes for both metacognitive skills and perseverance and distraction were used.</td></tr>
<tr><td>Sample size:
Group 1, n=34
Group 2, n=32</td><td colspan="2">Age range and average age (if applicable):
Group 1, children aged 5
Group 2, children aged 7 to 8</td><td>Setting of the study:
School, UK</td></tr>
<tr><td colspan="4">Link to metacognition:</td></tr>
<tr><td>Metacognition for something else (e.g., maths achievement)</td><td>Internally testing metacognition (e.g., solely measuring this or an aspect of it)
X
(Exploring how metacognition can be measured in young children)</td><td>Testing the tool (e.g., assessing its reliability or validity)</td><td>Extra info (if applicable)</td></tr>
</table>

Type of study:					
Pre/Post-test	Longitudinal	Experimental X (Quasi without control group)	Other	Unclear	Extra info

Reliability:	**Validity:**
Inter-rater reliability Internal consistency measured by Cronbach's alpha: self-regulation factor α=0.96 and social regulation factor α=0.86	Correlations with the CHILD questionnaire

Administration (who administers measure/training required):
Teachers

Strengths:

- Utilises observational coding of children's non-verbal behaviours and verbalisations during a problem-solving task; less reliance upon children's language, ability to read and/or prior knowledge.
- Suitable for use with younger children.
- Instrument used in conjunction with Children's Independent Learning Development (CHILD) questionnaire – teachers completed - to obtain alternative view of children's metacognitive skills and to add validation of metacognitive skills coding scheme.

Weaknesses:

- Smaller sample sizes used.
- Time consuming to code videos capturing observational data.
- Task specific.
- Instrument does not allow for children to verbally elaborate on their behaviour or comments. Authors recommend adapting instrument to add carefully structured evaluation questions at the end of the task.

Adaptions made to original instrument:	**Record:**
N/A	N/A

Related records: 1

Bryce, D., Whitebread, D. & Szűcs, D. (2015). The relationships among executive functions, metacognitive skills and educational achievement in 5 and 7 year-old children. *Metacognition Learning* **10**, 181–198 https://doi.org/10.1007/s11409-014-9120-4

Table 52: Triple Task Procedure in Mathematics

<table>
<tr><td colspan="6">Name and type of instrument:
Triple Task Procedure in Mathematics (TTPM)</td></tr>
<tr><td colspan="6">Aspect of metacognition measured:
Metacognitive monitoring</td></tr>
<tr><td colspan="6">First record (full reference, must have detailed methods and details of reliability and validity):
García, T., Rodríguez, C., González-Castro, P., González-Pienda, J. A., & Torrance, M. (2016). Elementary students' metacognitive processes and post-performance calibration on mathematical problem-solving tasks. Metacognition and Learning, 11(2), 139–170. https://doi.org/10.1007/s11409-015-9139-1</td></tr>
<tr><td colspan="6">Definition of metacognition associated with original development measure:
Zimmerman's model of forethought, performance and self-reflection</td></tr>
<tr><td colspan="6">Aim of the study:
Explore the relationship between post-performance calibration accuracy and metacognitive judgements of performance.</td></tr>
<tr><td colspan="6">Description of the tool or method:
Two mathematics problems are provided. Post performance judgements are collected related to how successful they were (yes/no).
Also measured how long it took to complete each of the metacognitive steps.</td></tr>
<tr><td colspan="2">Sample size:
n=524</td><td colspan="1">Age range and average age (if applicable):
Children aged 10 to 13</td><td colspan="3">Setting of the study:
School, Northern Spain</td></tr>
<tr><td colspan="6">Link to metacognition:</td></tr>
<tr><td>Metacognition for something else (e.g., maths achievement)
X
(Mathematics)</td><td>Internally testing metacognition (e.g., solely measuring this or an aspect of it)</td><td>Testing the tool (e.g., assessing its reliability or validity)</td><td colspan="3">Extra info (if applicable)</td></tr>
<tr><td colspan="6">Type of study:</td></tr>
<tr><td>Pre/Post-test</td><td>Longitudinal</td><td>Experimental</td><td>Other
X
(Descriptive of process)</td><td>Unclear</td><td>Extra info</td></tr>
</table>

Reliability:	Validity:

Administration (who administers measure/training required):
Teachers or SSOs

Strengths:

- Simple to administer.

Weaknesses:

- No assessment of reliability or validity.
- Post-performance judgments are dichotomous in nature.
- Only two mathematics problems used. The authors note that including 'more problems would lead to a clearer measure of post-performance judgments and actual performance stability' (p. 165).
- Study initially aimed to increase ecological validity, but authors explain that contextual factors, including teachers not being present during the evaluation, have compromised this attempt (p. 166).

Adaptions made to original instrument:	Record:
N/A	N/A

Related records: 0

1. Appendix: Quality assessment of the included reviews according to Study Quality and Assessment Tools

(https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools)

Table 53: Quality assessment of the included reviews according to Study Quality and Assessment Tools

Reference	Population	Type of review Systematic (S), meta-analysis (M), other	1. Is the review based on a focused question that is adequately formulated and described?	2. Were eligibility criteria for included and excluded studies predefined and specified?	3. Did the literature search strategy use a comprehensive, systematic approach?	4. Were titles, abstracts, and full-text articles dually and independently reviewed for inclusion and exclusion to minimize bias?	5. Was the quality of each included study rated independently by two or more reviewers using a standard method to appraise its internal validity?	6. Were the included studies listed along with important characteristics and results of each study?	7. Was publication bias assessed?	8. Was heterogeneity assessed? (This question applies only to meta-analyses.)
(Blewitt et al., 2018)	2-6 year olds in ECEC	S/M	Yes: RQ = examining the social, emotional, and early learning outcomes associated with universal curriculum-based SEL programs delivered to children aged 2 to 6 years in center-based ECEC settings	Yes	Yes PRISMA	Yes	Yes	Yes	Yes	Yes
(Corcoran et al., 2018)	PreK-12	S/M	Yes: RQ = explored the research regarding the effects of pre-K-12 school-based social and emotional learning interventions on reading, mathematics, and science achievement	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Day et al., 2022)	preschool	Scoping review of S	Yes: RQ= examining early SR-intervention research to identify the characteristics of pre-school interventions that show significant and strong effects on young children's SR	Yes	Yes PRISMA for scoping reviews	No- second review only applied to a random selection (25%)	Yes	Yes	No	N/A
(Dent & Koenka, 2016)	Elementary and secondary	M	Yes: RQ= explores the relationship between academic achievement and the meta-cognitive and cognitive processes of self-regulated learning for students in elementary and secondary school	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Djamnezhad et al., 2021)	Pre school 0-7 years old	Systematic Map of S	Yes: RQ= This overview aims to: 1) identify existing systematic reviews on universal, curriculum-based SEL interventions in preschool settings, assess their risk of bias, describe their characteristics and 2) synthesize the findings of the reviews with high methodological quality, and 3) identify knowledge gaps in practice relevant questions in the SEL domain	Yes	Yes PRISMA	Yes	Yes	Yes	Yes	N/A
(Eadeh et al., 2021).	adolescents	M	Yes: interventions for emotional regulation	Yes	Yes PRISMA	Yes	Yes	Yes	Yes	Yes
(Luo et al., 2022)	preschool	S/M	Yes: RQ= Research Question 1: What were the attributes of study participants and interventions involved in the review? Research Question 2: Did classroom-wide social–emotional interventions yield statistically significant and noteworthy mean effects for preschool children's	Yes	Yes PRISMA	Yes	Yes	Yes	Yes	Yes

			social, emotional, and behavioural outcomes? Research Question 3: Did select study or intervention characteristics moderate obtained intervention effects?							
(Murano et al., 2020)	preschool	M	Yes: RQ=What is the overall effect of universal SEL interventions on the development of social and emotional skills in preschoolers? 2. What is the overall effect of universal SEL interventions on the reduction of problem behaviours? 3. What is the overall effect of targeted SEL interventions on the development of social and emotional skills in preschoolers receiving targeted social and emotional programs? 4. What is the effect of targeted SEL interventions on the reduction of problem behaviors? 5. Do any of the following factors moderate gains in social and emotional skills and reductions in problem behaviors in universal or targeted intervention programs: program type; fidelity of implementation; duration of exposure to program, participant SES, age, or risk-status? 6. Do methodological aspects of study design (RCT, quasi-experimental) or measurement type (student task, teacher-report, parent-report, or observation) moderate the reported development of social and emotional skills and reduction of problem behaviors in universal and targeted interventions?	Yes	No	Yes	Yes	Yes	Yes	Yes
(Murray et al., 2022)	Early adolescents	M	Yes: RQ= 1) What is the overall effect of SR interventions with different theoretical mechanisms on outcomes for early adolescents? 2) How well does the intervention approach (predominantly cognitive vs. predominantly emotional) align with outcome effects (cognitive, emotional, behavioral)? 3) To what extent do effects vary by (a) five different intervention approaches, (b) outcome, and (c) measurement type	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Pandey et al., 2018)	Children and Adolescents	S/M	Yes" RQ=What is the effectiveness of universal self-regulation–based interventions to improve self-regulation and affect health and social outcomes in children and adolescents?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Sankalaite et al., 2021)	Pre school and primary school	S	Yes:RQ=To assess whether school-/class-wide interventions are effective and whether it depends on the type of manipulation (i.e., dyadic vs. classroom-	Yes	Yes	Yes	Yes	Yes	Yes	N/A

			level) and component(s) being activated (e.g., instructional vs. emotional support); To compare and contrast the effects of these interventions on EF and SR, and their distinct components.							
(Smithers et al., 2018)	0-12 yoa	S/M	Yes: RQ= to review the evidence on effects of improving different types of non-cognitive skills on later academic, psychosocial, cognitive and language, and health outcomes	Yes	Yes PRISMA	Yes	Yes	Yes	Yes	Yes
(Ştefan et al., 2022)	pre school	S	Yes: RQ= (1) to classify classroom-wide SEL programs according to the criteria for evidence-based interventions; (2) to synthesize studies of programs categorized as well-established; and (3) to analyse study-level and overall risk of bias	Yes	Yes PRISMA	Yes	Yes	Yes	No	N/A
(Xu et al., 2022)	K-12 and tertiary settings	M	Yes: RQ= the efficacy of self-regulated learning interventions on academic achievement in online and blended environments in K-12 and higher education	Yes	Yes	Yes	Yes	Yes	Yes	Yes

2. Appendix: Papers excluded and reason for the exclusion

Table 54: Papers excluded and the reason for exclusion

Paper reference	**Rationale for rejection**	**Database**
Desoete, A. (2008). Multi-method assessment of metacognitive skills in elementary school children: how you test is what you get. *Metacognition and Learning*, *3*(3), 189–206. https://doi.org/10.1007/s11409-008-9026-0	n=20 and therefore statistical implications lack power	ERIC
Casey, E.J., Gill, P., Pennington, L., & Mireles, S. V. (2018). Lines, roamers, and squares: Oh my! using floor robots to enhance Hispanic students' understanding of programming. Education and Information Technologies, 23(4), 1531–1546. https://doi.org/10.1007/s10639-017-9677-z	Not related to metacognition	ERIC
Tillema, M., van den Bergh, H., Rijlaarsdam, G., & Sanders, T. (2011). Relating self reports of writing behaviour and online task execution using a temporal model. Metacognition and Learning, 6(3), 229–253. https://doi.org/10.1007/s11409-011-9072-x	Uses a tool for metacognition that was previously used for a different task and is consequently not valid	ERIC
Yildiz, E., Akpinar, E., Tatar, N., & Ergîn, Ömer. (2009). Exploratory and confirmatory factor analysis of the metacognition scale for primary school students. Educational Sciences : Theory & Practice, 9(3), 1591–1604.	Instrument is not in English	ERIC
Annevirta, T., & Vauras, M. (2006). Developmental Changes of Metacognitive Skill in Elementary School Children. *The Journal of Experimental Education*, *74*(3), 195–226. https://doi.org/10.3200/JEXE.74.3.195-226	Impossible to source original tool and the instrument is in Finnish	ProQuest
Minguela, M., Solé, I., & Pieschl, S. (2015). Flexible self-regulated reading as a cue for deep comprehension: evidence from online and offline measures. *Reading & Writing*, *28*(5), 721–744. https://doi.org/10.1007/s11145-015-9547-2	Original tool not validated for metacognition and new tool not validated at all	ProQuest
Roeschl-Heils, A., Schneider, W., & van Kraayenoord, C. E. (2003). Reading, metacognition and motivation: A follow-up study of German students in Grades 7 and 8. *European Journal of Psychology of Education*, *18*(1), 75–86. https://doi.org/10.1007/BF03173605	Refers to an unpublished manuscript for it's tool so no validation or reliability besides a reference to cronbach's	ERIC
Sparks, R. L., Patton, J., & Luebbers, J. (2018). L2 anxiety and the foreign language reading anxiety scale: Listening to the evidence. *Foreign Language Annals*, *51*(4), 738–762. https://doi.org/10.1111/flan.12361	Original validation in Dutch but English translation included. Can't get access to the Dutch validation so cannot include	ProQuest
Whetstone, P. J., Gillmor, S. C., & Schuster, J. G. (2015). Effects of a Metacognitive Social Skill Intervention in a Rural Setting with At-Risk Adolescents. *Rural Special Education Quarterly*, *34*(2), 25–35. https://doi.org/10.1177/875687051503400205	Intervention is metacognitive but assessment is behavioural/emotional	ERIC

Dianovsky, M.T., & Wink, D.J. (2012). Student learning through journal writing in a general education chemistry course for pre-elementary education majors. Science Education, 96(3), 543-564	Focuses on university students therefore out of scope of age range for this review	ERIC
Adiguzel, A. & Orhan, A. (2017). The relation between English students' levels of self-regulation and metacognitive skills and their English achievements. Journal of Education and Practice, 8, 115-125.	Not available	ERIC
Diehl, H. L., Armitage, C. J., Nettles, D. H., & Peterson, C. (2011). The Three-Phase Reading Comprehension Intervention (3-RCI): A Support for Intermediate-Grade Word Callers. Reading Horizons, 51(2), 149.	Use metacognition in the intervention but does not measure it	Proquest
Efthymiou, G (2012). Portfolio Assessment of Speaking Skills in English as a Foreign Language in Primary Education. Research papers in language teaching and learning, 3(1), 200–224.	Not really about metacognition and not a quantitative paper	Proquest
Guerra E and Mellado G (2017) A-Book: A Feedback-Based Adaptive System to Enhance Meta-Cognitive Skills during Reading .Front. Hum. Neurosci. 11:98. doi: 10.3389/fnhum.2017.00098	More about comprehension than metacongition. Too difficult to separate the two to be meaningful	Proquest
Maloney, D. M., Ryan, A., & Ryan, D. (2021). Developing Self-Regulation Skills in Second Level Students Engaged in Threshold Learning: Results of a Pilot Study in Ireland. Contemporary School Psychology, 25(1), 109–123. https://doi.org/10.1007/s40688-019-00254-z	About emotional regulation rather than meta-cognition	Proquest
Pearson, H. (2022). THE SCHOOL EXPERIMENT. Nature (London), 605(7911), 608–611. https://doi.org/10.1038/d41586-022-01387-7	Article agrigating evidence on educational implementations but fairly general and no relevant instruments mentioned	Proquest
Pirrone, C.; Di Corrado, D.; Privitera, A.; Castellano, S.; Varrasi, S. Students' Mathematics Anxiety at Distance and In-Person Learning Conditions during COVID-19 Pandemic: Are There Any Differences? An Exploratory Study. Educ. Sci. 2022, 12, 379. https:// doi.org/10.3390/educsci12060379	Instrument validated in an Italian only publication. Reference to Mathematics Anxiety Rating Scale but this is from 1972	Proquest
Haines, M.-A., Cornish, L. & Bannister-Tyrrell, M. (2020). Investigating reading, critical-thinking and metacognitive abilities of possible twice-exceptional primary/elementary school students: An on-line inquiry. *TalentEd, 32*, 52–80.	Only six students used (and two were identifical twins)	A+ Education
Ozcan, Z. C., & Gumus, A. E. (2019). A modeling study to explain mathematical problem-solving performance through metacognition, self-efficacy, motivation, and anxiety. The Australian Journal of Education, 63(1), 116–134. https://doi.org/10.1177/0004944119840073	Original instrument 'the metacognitive experience scale' can not be accessed	A+ Education

Power, A. (2006). On the use of the metacognitive strategy of self-questioning while studying music of a culture. Australian Journal of Music Education, 1, 4–11.	Uses self questioning and no quantitative methodology	A+ Education
Braga, L. W., Rossi, L., Moretto, A. L. L., Da Silva, J. M., & Cole, M. (2012). Empowering preadolescents with ABI through metacognition: Preliminary results of a randomized clinical trial. NeuroRehabilitation (Reading, Mass.), 30(3), 205–212. https://doi.org/10.3233/NRE-2012-0746	Two instruments referenced are both not in English	Cochrane
Ghetti, S., Papini, S., & Angelini, L. (2006). The development of the memorability-based strategy: Insight from a training study. Journal of Experimental Child Psychology, 94(3), 206–228. https://doi.org/10.1016/j.jecp.2006.01.004	Described assessments of memorability as being a metacognitive process rather than actually measuring anything related to metacognition	Cochrane
Fahey, P., & Cronen, L. (2016). Digital Portfolios in Action: Acknowledging Student Voice and Metacognitive Understanding in Art. The Clearing House, 89(4-5), 135–143. https://doi.org/10.1080/00098655.2016.1170450	not quantitative	ERIC
Kwon, S. K., & Yu, G. (2023). Investigating differences in test-takers' use of cognitive and metacognitive strategies in audio-only and video-based listening comprehension test. System (Linköping), 114, 103017. https://doi.org/10.1016/j.system.2023.103017	Test translated and adapted in Korean, original test for undergraduate students	Science Direct
Cihanoglu, M. O. (2012). Metacognitive Awareness of Teacher Candidates. Procedia, Social and Behavioral Sciences, 46, 4529–4533. https://doi.org/10.1016/j.sbspro.2012.06.290	For university students	Science Direct
Pennequin, V., Questel, F., Delaville, E., Delugre, M., & Maintenant, C. (2020). Metacognition and emotional regulation in children from 8 to 12 years old. British Journal of Educational Psychology, 90(1), 1–16. https://doi.org/10.1111/bjep.12305	Rejected as from French version of a questionnaire that was validated in a paper that I cannot source	ERIC
Babayigit, Ö., (2019). Examination the Metacognitive Reading Strategies of Secondary School Sixth Grade Students. International Journal of Progressive Education, v15 n3 p1-12	rejected as original validated tool not in English	ERIC
Mokhtari, K., & Reichard, C. (2004). Investigating the strategic reading processes of first and second language readers in two different cultural contexts. System (Linköping), 32(3), 379–394. https://doi.org/10.1016/j.system.2004.04.005	For university students	ERIC
Baliram, N., & Ellis, A. K. (2019). The impact of metacognitive practice and teacher feedback on academic achievement in mathematics. School Science and Mathematics, 119(2), 94–104. https://doi.org/10.1111/ssm.12317	Measures used were not for metacognition	ERIC
Barzilai, S., & Zohar, A. (2012). Epistemic Thinking in Action: Evaluating and Integrating Online Sources. Cognition and Instruction, 30(1), 39–85. https://doi.org/10.1080/07370008.2011.636495	Measures used were not for metacognition	ERIC

Bianco, F., Lombardi, E., Lecce, S., Marchetti, A., Massaro, D., Valle, A., & Castelli, I. (2021). Supporting Children's Second-order Recursive Thinking and Advanced ToM Abilities: A Training Study. Journal of Cognition and Development, 22(4), 561–584. https://doi.org/10.1080/15248372.2021.1901712	rejected as original validated tool was not in English	ERIC
Bigozzi, L., Vezzani, C., Tarchi, C., & Fiorentini, C. (2011). The role of individual writing in fostering scientific conceptualization. European Journal of Psychology of Education, 26(1), 45–59. https://doi.org/10.1007/s10212-010-0031-8	Measures used were not for metacognition	Scopus
Blasco, J.A. (2016). The relationship between writing anxiety, writing self-efficacy, and Spanish EFL students' use of metacognitive writing strategies: a case study. *Journal of English Studies, 14, 7-45*	A case study of six students	Scopus
Bond, J. B., & Ellis, A. K. (2013). The Effects of Metacognitive Reflective Assessment on Fifth and Sixth Graders' Mathematics Achievement. School Science and Mathematics, 113(5), 227–234. https://doi.org/10.1111/ssm.12021	Measures used were not for metacognition	ERIC
Borge, M., & White, B. (2016). Toward the Development of Socio-Metacognitive Expertise: An Approach to Developing Collaborative Competence. Cognition and Instruction, 34(4), 323–360. https://doi.org/10.1080/07370008.2016.1215722	Measures used were not for metacognition	ERIC
Briesmaster, M., & Etchegaray, P. (2017). Coherence and cohesion in EFL students' writing production: The impact of a metacognition-based intervention. Íkala : Revista de Lenguaje y Cultura, 22(2), 183–202. https://doi.org/10.17533/udea.ikala.v22n02a02	Measure for metacognition were qualitative	Scopus
Dahl, A. C., Carlson, S. E., Renken, M., McCarthy, K. S., & Reynolds, E. (2021). Materials matter: An exploration of text complexity and its effects on middle school readers' comprehension processing. Language, Speech & Hearing Services in Schools, 52(2), 702–716. https://doi.org/10.1044/2021_LSHSS-20-00117	Measures used were not for metacognition	Scopus
De stasio Simona, & Di chiacchio Carlo. (2015). Metacognitive and self regulated learning strategies profiles: An exploratory survey of a group of high school students. Mediterranean Journal of Social Sciences, 6(4), 656–663. https://doi.org/10.5901/mjss.2015.v6n4s3p656	rejected as original validated tool not in English	Scopus
Dejonckheere, P. J. N., Van de Keere, K., Tallir, I., & Vervaet, S. (2013). Primary school science : implementation of domain-general strategies into teaching didactics. Australian Educational Researcher, 40(5), 583–614. https://doi.org/10.1007/s13384-013-0119-7	Measures used were not for metacognition	ERIC
Power, A. (2006). On the use of the metacognitive strategy of self-questioning while studying music of a culture. *Australian Journal of Music Education*, (1), 4-11.	Lack of validation + small sample size	A+ Education
Munzar, B., Muis, K. R., Denton, C. A., & Losenno, K. (2021). Elementary students' cognitive and affective responses to impasses during mathematics problem solving. Journal of Educational Psychology, 113(1), 104–124. https://doi.org/10.1037/edu0000460	Not about metacognition	Unknown

Wassenburg, S. I., Bos, L. T., de Koning, B. B., & van der Schoot, M. (2015). Effects of an Inconsistency-Detection Training Aimed at Improving Comprehension Monitoring in Primary School Children. Discourse Processes, 52(5-6), 463–488. https://doi.org/10.1080/0163853X.2015.1025203	training is metacognitive but about comprehension so measures are not valid	ERIC
Gelderen, A. van, Schoonen, R., Stoel, R. D., Glopper, K. de, & Hulstijn, J. (2007). Development of Adolescent Reading Comprehension in Language 1 and Language 2. Journal of Educational Psychology, 99(3), 477–491. https://doi.org/10.1037/0022-0663.99.3.477	instrument is in Dutch	ERIC
Divrik, R., Pilten, P., & Taş, A. M. (2020). Effect of inquiry-based learning method supported by metacognitive strategies on fourth-grade students' problem-solving and problem-posing skills: A mixed methods research. International Electronic Journal of Elementary Education, 13(2), 287–308. https://doi.org/10.26822/iejee.2021.191	The quantitative element of this study is not about metacognition but problem solving	ERIC
Eilers, L. H., & Pinkley, C. (2006). Metacognitive strategies help students to comprehend all text. Reading Improvement, 43(1), 13–29.	No suitable quantitative measure of metacognition	ERIC
Hartman, H. J. (2015). Engaging Adolescent Students' Metacognition Through WebQuests: A Case Study of Embedded Metacognition. In Metacognition: Fundaments, Applications, and Trends (Vol. 76, pp. 135–166). Springer International Publishing AG. https://doi.org/10.1007/978-3-319-11062-2_6	Qualitative	Scopus
Hurme, T.-R., Palonen, T., & Järvelä, S. (2006). Metacognition in joint discussions: An analysis of the patterns of interaction and the metacognitive content of the networked discussions in mathematics. Metacognition and Learning, 1(2), 181–200. https://doi.org/10.1007/s11409-006-9792-5	Only 16 participants	Scopus
López-Vargas, O., Ibáñez-Ibáñez, J., & Racines-Prada, O. (2017). Students' Metacognition and Cognitive Style and Their Effect on Cognitive Load and Learning Achievement. Educational Technology & Society, 20(3), 145–157.	Uses metacognition but does not measure it	Scopus
Preiss, D. D., Ibaceta, M., Ortiz, D., Carvacho, H., & Grau, V. (2019). An exploratory study on mind wandering, metacognition, and verbal creativity in chilean high school students. Frontiers in Psychology, 10, 1118–1118. https://doi.org/10.3389/fpsyg.2019.01118	No valid metacognitive measure	Scopus
Wall, K. (2008). Understanding metacognition through the use of pupil views templates: Pupil views of Learning to Learn. Thinking Skills and Creativity, 3(1), 23–33. https://doi.org/10.1016/j.tsc.2008.03.004	Qualitative	Science Direct
Kyriakides, L., Anthimou, M., & Panayiotou, A. (2020). Searching for the impact of teacher behavior on promoting students' cognitive and metacognitive skills. Studies in Educational Evaluation, 64, 100810. doi:https://doi.org/10.1016/j.stueduc.2019.100810	Study not conducted in an OECD member country.	Science Direct
Teng, M. F., & Zhang, L. J. (2021). Development of children's metacognitive knowledge, reading, and writing in English as a foreign language: Evidence from longitudinal data using multilevel models. *British Journal of Educational Psychology, 91*(4), 1202-1230. doi:10.1111/bjep.12413	Study not conducted in an OECD member country.	Scopus

Callan, G. L., & Cleary, T. J. (2018). Multidimensional assessment of self-regulated learning with middle school math students. *School Psychology Quarterly*, *33*(1), 103.	Original instrument used with Taiwanese university students + no validation	ERIC
Stavropoulou, G., Stamovlasis, D., & Gonida, S. E. (2023). Probing the effects of perceived teacher goals and achievement-goal orientations on students' self-efficacy, cognitive and metacognitive strategies in writing: A person-centered approach. *Learning and Motivation*, *82*, 101888.	Original instrument used with university students	SD
Wong, K. M., & Mak, P. (2019). Self-Assessment in the Primary L2 Writing Classroom. *Canadian Modern Language Review, 75*(2), 183-196. Retrieved from https://go.openathens.net/redirector/unisa.edu.au?url=https://www.proquest.com/scholarly-journals/self-assessment-primary-l2-writing-classroom/docview/2461129464/se-2?accountid=14649	Not about metacognition	ERIC
Sipos, K., Ioniță, G. I., & Kutzschebauch, F. (2023). Online Self-Assessment in Mathematics at the University of Bern. *International Journal of Emerging Technologies in Learning, 18*(3), 185-190. doi:10.3991/ijet.v18i03.36627	Original instrument used with university students	Scopus
Nordell, S. E. (2009). Learning how to learn: A model for teaching students learning strategies. Bioscene, 35(1), 35-42. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-68349125130&partnerID=40&md5=6e1c9dc648aaea8d0bd31194410ae1d7	No suitable quantitative measure for metacognition and study conducted with university students	Scopus
Kaderavek, J. N., Gillam, R. B., Ukrainetz, T. A., Justice, L. M., & Eisenberg, S. N. (2004). School-Age Children's Self-Assessment of Oral Narrative Production. *Communication Disorders Quarterly, 26*(1), 37-48. Retrieved from https://go.openathens.net/redirector/unisa.edu.au?url=https://www.proquest.com/scholarly-journals/school-age-childrens-self-assessment-oral/docview/62117657/se-2?accountid=14649	No suitable quantitative measure of metacognition	ERIC
Breed, B., Mentz, E., & van der Westhuizen, G. (2014). A Metacognitive Approach to Pair Programming: Influence on Metacognitive Awareness. *Electronic Journal of Research in Educational Psychology, 12*(1), 33-60. doi:https://doi.org/10.14204/ejrep.32.13104	Study not conducted in an OECD member country.	ERIC
Zachariou, A., Bonneville-Roussy, A., Hargreaves, D., & Neokleous, R. (2023). Exploring the effects of a musical play intervention on young children's self-regulation and metacognition. *Metacognition and Learning*. doi:10.1007/s11409-023-09342-1	Study not conducted in an OECD member country.	Scopus
Robbers, E., Donche, V., De Maeyer, S., & Van Petegem, P. (2018). A Longitudinal Study of Learning Conceptions on the Transition between Primary and Secondary Education. *Research Papers in Education, 33*(3), 375-392. doi:https://doi.org/10.1080/02671522.2017.1329337	Instrument does not measure metacognition	ERIC
Schellings, G. L., van Hout-Wolters, B. H. A. M., Veenman, M. V. J., & Meijer, J. (2013). Assessing Metacognitive Activities: The In-Depth Comparison of a Task-Specific Questionnaire with Think-Aloud Protocols. *European Journal of Psychology of Education, 28*(3), 963-990. doi:https://doi.org/10.1007/s10212-012-0149-y	n=20 therefore statistical implications lack power	ERIC

Rogiers, A., Merchie, E., & Van Keer, H. (2020). What They Say Is What They Do? Comparing Task-Specific Self-Reports, Think-Aloud Protocols, and Study Traces for Measuring Secondary School Students' Text-Learning Strategies. *European Journal of Psychology of Education, 35*(2), 315-332. doi:https://doi.org/10.1007/s10212-019-00429-5	Instrument does not measure metacognition	ERIC
Richardson, H. (2017). *Building Self-Efficacy in Fifth Grade Art Students through Authentic Assessments and Self-Regulating Strategies.* Retrieved from https://go.openathens.net/redirector/unisa.edu.au?url=https://www.proquest.com/dissertations-theses/building-self-efficacy-fifth-grade-art-students/docview/1968431262/se-2?accountid=14649	thesis which examines how teachers impact students' self-confidence in art making.	ERIC
Deekens, V. M., Greene, J. A., & Lobczowski, N. G. (2018). Monitoring and depth of strategy use in computer-based learning environments for science and history. *British Journal of Educational Psychology, 88*(1), 63-79. doi:10.1111/bjep.12174	Instrument does not measure metacognition	Scopus
Silver, D., Hansen, M., Herman, J., Silk, Y., & Greenleaf, C. L. (2011). *IES Integrated Learning Assessment Final Report. CRESST Report 788*. Retrieved from https://go.openathens.net/redirector/unisa.edu.au?url=https://www.proquest.com/reports/ies-integrated-learning-assessment-final-report/docview/881464519/se-2?accountid=14649	n=20 therefore statistical implications lack power	ERIC
Sevgi, S., & Karakaya, M. (2020). Investigation of Metacognition Awareness Levels and Problem Solving Skills of Middle School Students. *International Online Journal of Primary Education, 9*(2), 260-270. Retrieved from https://go.openathens.net/redirector/unisa.edu.au?url=https://www.proquest.com/scholarly-journals/investigation-metacognition-awareness-levels/docview/2535397252/se-2?accountid=14649	Original instrument is not in English	ERIC
Özcan, Z. Ç. (2016). The relationship between mathematical problem-solving skills and self-regulated learning through homework behaviours, motivation, and metacognition. *International Journal of Mathematical Education in Science and Technology, 47*(3), 408-420. doi:10.1080/0020739X.2015.1080313	Contains two original instruments, but 1 not available and other is from a conference	Scopus
Chatzipanteli, A., Digelidis, N., Karatzoglidis, C., & Dean, R. (2016). A Tactical-Game Approach and Enhancement of Metacognitive Behaviour in Elementary School Students. *Physical Education and Sport Pedagogy, 21*(2), 169-184. doi:https://doi.org/10.1080/17408989.2014.931366	Qualitative instruments used to assess metacognition	ERIC
Mateos, M., Martin, E., Villalon, R., & Luna, M. (2008). Reading and Writing to Learn in Secondary Education: Online Processing Activity and Written Products in Summarizing and Synthesizing Tasks. *Reading and Writing: An Interdisciplinary Journal, 21*(7), 675-697. doi:https://doi.org/10.1007/s11145-007-9086-6	Instrument does not measure metacognition	ERIC
McKeown, R. G., & Gentilucci, J. L. (2007). Think-Aloud Strategy: Metacognitive Development and Monitoring Comprehension in the Middle School Second-Language Classroom. *Journal of Adolescent & Adult Literacy, 51*(2), 136-147. doi:https://doi.org/10.1598/JAAL.51.2.5	n=27 and therefore statistical implications lack power	ERIC
Parkinson, M. M., & Dinsmore, D. L. (2018). Multiple Aspects of High School Students' Strategic Processing on Reading Outcomes: The Role of Quantity, Quality, and Conjunctive Strategy Use. *British Journal of Educational Psychology, 88*(1), 42-62. doi:https://doi.org/10.1111/bjep.12176	n=21 and therefore statistical implications lack power	ERIC

van der Stel, M., & Veenman, M. V. J. (2008). Relation between Intellectual Ability and Metacognitive Skillfulness as Predictors of Learning Performance of Young Students Performing Tasks in Different Domains. *Learning and Individual Differences, 18*(1), 128-134. doi:https://doi.org/10.1016/j.lindif.2007.08.003	n=32 and therefore statistical implications lack power	ERIC
van der Stel, M., & Veenman, M. V. J. (2010). Development of Metacognitive Skillfulness: A Longitudinal Study. *Learning and Individual Differences, 20*(3), 220-224. doi:https://doi.org/10.1016/j.lindif.2009.11.005	n=32 and therefore statistical implications lack power	ERIC
Kertz, S., & Woodruff-Borden, J. (2013). The role of metacognition, intolerance of uncertainty, and negative problem orientation in children's worry. *Behavioural and Cognitive Psychotherapy, 41*(2), 243-248. doi:10.1017/S1352465812000641	Instrument has been developed for students diagnosed with an anxiety disorder	Scopus
Vorhölter, K. (2018). Conceptualization and Measuring of Metacognitive Modelling Competencies: Empirical Verification of Theoretical Assumptions. *ZDM: The International Journal on Mathematics Education, 50*(1-2), 343-354. doi:https://doi.org/10.1007/s11858-017-0909-x	Adapted tool not validated and original tool is in German	ERIC
Leutwyler, B. (2009). Metacognitive Learning Strategies: Differential Development Patterns in High School. Metacognition and Learning, 4(2), 111-123. doi:https://doi.org/10.1007/s11409-009-9037-5	Limited discussion of instrument and no validation.	ERIC
Soto, C., Gutiérrez de Blume, A. P., Jacovina, M., McNamara, D., Benson, N., & Riffo, B. (2019). Reading Comprehension and Metacognition: The Importance of Inferential Skills. *Cogent Education, 6*(1), 1-20. doi:https://doi.org/10.1080/2331186X.2019.1565067	Instrument only validated for Spanish-speaking populations in both Spain and Argentina	ERIC
Thielsch, C., Andor, T., & Ehring, T. (2015). Metacognitions, intolerance of uncertainty and worry: An investigation in adolescents. *Personality and Individual Differences, 74*, 94-98. doi:https://doi.org/10.1016/j.paid.2014.10.004	Some participants outside of age range (15 to 20 years old) and focus is not on metacognition	ScienceDirect
DiBenedetto, M. K., & Zimmerman, B. J. (2013). Construct and predictive validity of microanalytic measures of students' self-regulation of science learning. *Learning and Individual Differences, 26*, 30-41. doi:https://doi.org/10.1016/j.lindif.2013.04.004	Tool does not measure metacognition	ScienceDirect
Desoete, A., & Roeyers, H. (2006). Metacognitive Macroevaluations in Mathematical Problem Solving. *Learning and Instruction, 16*(1), 12-25. doi:https://doi.org/10.1016/j.learninstruc.2005.12.003	Instruments do not measure metacognition	ERIC
Doz, E., Cuder, A., Pellizzoni, S., Carretti, B., & Passolunghi, M. C. (2023). Arithmetic Word Problem-Solving and Math Anxiety: The Role of Perceived Difficulty and Gender. *Journal of Cognition and Development*. doi:10.1080/15248372.2023.2186692	Instrument does not measure metacognition	Scopus
Fergus, T. A., & Limbers, C. A. (2019). Reducing Test Anxiety in School Settings: A Controlled Pilot Study Examining a Group Format Delivery of the Attention Training Technique Among Adolescent Students. *Behavior Therapy, 50*(4), 803-816. doi:10.1016/j.beth.2018.12.001	Original instrument used to measure metacognition in	Scopus

	children diagnosed with anxiety disorders	
Forbes, K., & Fisher, L. (2018). The Impact of Expanding Advanced Level Secondary School Students' Awareness and Use of Metacognitive Learning Strategies on Confidence and Proficiency in Foreign Language Speaking Skills. *Language Learning Journal, 46*(2), 173-185. doi:https://doi.org/10.1080/09571736.2015.1010448	Instrument does not measure metacognition	ERIC
Ghetti, S., Papini, S., & Angelini, L. (2006). The development of the memorability-based strategy: insight from a training study. *Journal of Experimental Child Psychology, 94*(3), 206-228. doi:10.1016/j.jecp.2006.01.004	Instrument does not measure metacognition	Cochrane
Pearson, H. (2022). THE SCHOOL EXPERIMENT. *Nature, 605*(7911), 608-611. doi:https://doi.org/10.1038/d41586-022-01387-7	Does not contain an instrument to measure metacognition	ProQuest
Grazzani, I., & Ornaghi, V. (2012). How do use and comprehension of mental-state language relate to theory of mind in middle childhood? Cognitive Development, 27(2), 99-111. doi:https://doi.org/10.1016/j.cogdev.2012.03.002	Instrument does not measure metacognition	ScienceDirect
Hartman, H. J. (2015). Engaging adolescent students' metacognition through WebQuests: A case study of embedded metacognition. Intelligent Systems Reference Library, 76, 135-166. doi:10.1007/978-3-319-11062-2_6	Participants are university students.	Scopus
Hurme, T. R., Palonen, T., & Järvelä, S. (2006). Metacognition in joint discussions: An analysis of the patterns of interaction and the metacognitive content of the networked discussions in mathematics. *Metacognition and Learning, 1*(2), 181-200. doi:10.1007/s11409-006-9792-5	n=16 therefore statistical implications lack power	Scopus
Zhang, Y., Paquette, L., Baker, R. S., Bosch, N., Ocumpaugh, J., & Biswas, G. (2023). How Are Feelings of Difficulty and Familiarity Linked to Learning Behaviors and Gains in a Complex Science Learning Task? *European Journal of Psychology of Education, 38*(2), 777-800. doi:https://doi.org/10.1007/s10212-022-00616-x	Instrument does not measure metacognition	ERIC
van Loon, M. H., Bayard, N. S., Steiner, M., & Roebers, C. M. (2021). Connecting teachers' classroom instructions with children's metacognition and learning in elementary school. *Metacognition and Learning, 16*(3), 623-650. doi:10.1007/s11409-020-09248-2	Instrument does not measure metacognition	Scopus
Robbers, E., Donche, V., De Maeyer, S., & Van Petegem, P. (2018). A Longitudinal Study of Learning Conceptions on the Transition between Primary and Secondary Education. *Research Papers in Education, 33*(3), 375-392. doi:https://doi.org/10.1080/02671522.2017.1329337	Instrument does not measure metacognition	ERIC
Krebs, S. S., & Roebers, C. M. (2012). The Impact of Retrieval Processes, Age, General Achievement Level, and Test Scoring Scheme for Children's Metacognitive Monitoring and Controlling. *Metacognition and Learning, 7*(2), 75-90. doi:https://doi.org/10.1007/s11409-011-9079-3	No instrument for measuring metacognition.	ERIC

Mason, L., Boldrin, A., & Ariasi, N. (2010). Epistemic Metacognition in Context: Evaluating and Learning Online Information. *Metacognition and Learning, 5*(1), 67-90. doi:https://doi.org/10.1007/s11409-009-9048-2	Qualitative instrument used to measure metacognition	ERIC
Morris, J. E., Lummis, G. W., & Lock, G. (2017). Questioning Art: Factors Affecting Students' Cognitive Engagement in Responding. *Issues in Educational Research, 27*(3), 493-511. Retrieved from https://go.openathens.net/redirector/unisa.edu.au?url=https://www.proquest.com/scholarly-journals/questioning-art-factors-affecting-students/docview/1969014899/se-2?accountid=14649	Does not report on instrument aspect, explaining that further validation will be reported on in a subsequent publication, but no publication can be found	ERIC
Murray, J., Scott, H., Connolly, C., & Wells, A. (2018). The Attention Training Technique improves Children's ability to delay gratification: A controlled comparison with progressive relaxation. *Behaviour Research and Therapy, 104*, 1-6. doi:10.1016/j.brat.2018.02.003	Instrument does not measure metacognition	Scopus
Papaioannou, A. G., Simou, T., Kosmidou, E., Milosis, D., & Tsigilis, N. (2009). Goal orientations at the global level of generality and in physical education: Their association with self-regulation, affect, beliefs and behaviours. *Psychology of Sport and Exercise, 10*(4), 466-480. doi:https://doi.org/10.1016/j.psychsport.2009.01.003	Original instrument is in Greek.	ScienceDirect
Patel, J., Aldercotte, A., Tsapali, M., Serpell, Z. N., Parr, T., & Ellefson, M. R. (2021). The Zoo Task: A novel metacognitive problem-solving task developed with a sample of African American children from schools in high poverty communities. *Psychological Assessment, 33*(8), 795-802. doi:10.1037/pas0001033	Instrument does not measure metacognition	Scopus
Pesout, O., & Nietfeld, J. (2021). The Impact of Cooperation and Competition on Metacognitive Monitoring in Classroom Context. *Journal of Experimental Education, 89*(2), 237-258. doi:https://doi.org/10.1080/00220973.2020.1751577	Focuses on strategies and intervention, not instruments	ERIC
Raccanello, D., Vicentini, G., Rocca, E., Hall, R., & Burro, R. (2023). Preparing children to cope with earthquakes: Building emotional competence. *British Journal of Psychology*. doi:10.1111/bjop.12661	Limited discussion of instrument and no validation.	Scopus
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Vo, V. A., Li, R., Kornell, N., Pouget, A., & Cantlon, J. F. (2014). Young Children Bet on Their Numerical Skills: Metacognition in the Numerical Domain. *Psychological Science, 25*, 1712-1721. doi:10.1177/0956797614538458	n=45 and instrument has not been assessed for reliability or validity	Scopus
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Desoete, A., Baten, E., Vercaemst, V., De Busschere, A., Baudonck, M., & Vanhaeke, J. (2019). Metacognition and Motivation as Predictors for Mathematics Performance of Belgian Elementary School Children. *ZDM: The International Journal on Mathematics Education, 51*(4), 667-677. doi:https://doi.org/10.1007/s11858-018-01020-w	Limited discussion of instrument and no validation.	ERIC
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Pilegard, C., & Fiorella, L. (2016). Helping students help themselves: Generative learning strategies improve middle school students' self-regulation in a cognitive tutor. *Computers in Human Behavior, 65*, 121-126. doi:https://doi.org/10.1016/j.chb.2016.08.020	No instrument used to measure metacognition	ScienceDirect
Meijer, J., Veenman, M. V. J., & van Hout-Wolters, B. (2012). Multi-Domain, Multi-Method Measures of Metacognitive Activity: What Is All the Fuss about Metacognition ... Indeed? *Research Papers in Education, 27*(5), 597-627. doi:https://doi.org/10.1080/02671522.2010.550011	Refers to a questionnaire based on a past study being used to measure metacognition, but does not describe the instrument or provide any in-text referencing for original instrument used.	ERIC