Technical Appendix: Meta-cognition and self-regulation

EVIDENCE FOR LEARNING

Definition

Meta-cognition (sometimes known as 'learning to learn') and self-regulation approaches aim to help learners think about their own learning more explicitly so as to take increased responsibility for achievement. Meta-cognition involves consciously thinking about planning, monitoring and evaluating your own learning and is often considered to have two dimensions, knowledge and skillfulness or the extent to which a learner is aware of meta-cognitive strategies to manage learning and the individual's capability at putting these strategies into practice. Approaches usually focus on teaching pupils specific strategies to set goals, and monitor and evaluate their own academic development in relation to particular learning tasks and activities. Self-regulation relates to meta-cognitive skillfulness but also involves managing one's own motivation towards learning and the development of dispositions such as resilience and perseverance. In practical terms, the intention is often to provide pupils with a repertoire of strategies to choose from during learning activities, this often involves Feedback on use of different strategies. Approaches also frequently involve Collaborative learning activities and techniques.

Search terms:

Meta-cognition*, executive function, self-regulation*

Evidence rating

Extensive: There are seven meta-analyses with five undertaken in the last 10 years. These are mainly from experimental studies which were often undertaken in schools and which evaluated impact on pupil attainment data as well as more general cognitive outcomes with some exploration of the causes of any identified heterogeneity. The underlying studies, however, vary in quality. Most of the estimates of impact are high with pooled effect falling in a narrow range (0.62 to 0.71). Recent single studies have not consistently achieved these gains.

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* Studies marked with an asterisk are included in the summary of effects

References for Australasia-specific studies can be found in the *Australasian Research Summary* for this topic, available as a link on the Toolkit page.

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Summary of effects	
Meta-analyses	**Overall effect size**
Abrami et al. 2008	0.34
Chiu 1998	0.67
Dignath et al. 2008	0.62
Donker et al. 2014	0.66
Haller et al. 1988	0.71
Higgins et al. 2005	0.62
Klauer & Phye 2008	0.69
Recent single studies	
Crawford et al. 2014 (EEF- LIT Programme)	0.09
Hanley, Slavin & Elliott 2015 (EEF Thinking Doing	0.22
Gorard et al. 2015 (EEF P4C) Reading	0.14
NIESR 2015 (EEF Changing Mindsets)	
Torgerson et al. 2014 (EEF- Using Self-Regulation to	0.74
Tracy, Reid & Graham, 2009 (writing overall)	0.47
Weighted mean effect size	0.62

For more information about the effect sizes in the Toolkit, click here.

Meta-analyses and abstracts	
Study	**Abstract**
Abrami et al. 2008	Critical thinking (CT), or the ability to engage in purposeful, self-regulatory judgment, is widely recognized as an important, even essential, skill. This article describes an on-going meta-analysis that summarizes the available empirical evidence on the impact of instruction on the development and enhancement of critical thinking skills and dispositions. We found 117 studies based on 20,698 participants, which yielded 161 effects with an average effect size (g+) of 0.341 and a standard deviation of 0.610. The distribution was highly heterogeneous (QT = 1,767.86, p < .001). There was, however, little variation due to research design, so we neither separated studies according to their methodological quality nor used any statistical adjustment for the corresponding effect sizes. Type of CT intervention and pedagogical grounding were substantially related to fluctuations in CT effects sizes, together accounting for 32% of the variance. These findings make it clear that improvement in students' CT skills and dispositions cannot be a matter of implicit expectation. As important as the development of CT skills is considered to be, educators must take steps to make CT objectives explicit in courses and also to include them in both pre-service and in-service training and faculty development.
Chiu 1998	In this paper, meta-analysis is used to identify components that are associated with effective metacognitive training programs in reading research. Forty-three studies, with an average of 81 students per study, were synthesized. It was found that metacognitive training could be more effectively implemented by using small-group instruction, as opposed to large-group instruction or one-to-one instruction. Less intensive programs were more effective than intensive programs. Program intensity was defined as the average number of days in a week that instruction was provided to students. Students in higher grades were more receptive to the intervention. Measurement artifacts, namely teaching to the test and use of non-standardized tests and the quality of the studies synthesized played a significant role in the evaluation of the effectiveness of the metacognitive reading intervention.

Dignath et al. 2008	Recently, research has increasingly focused on fostering self-regulated learning amongst young children. To consider this trend, this article presents the results of a differentiated meta-analysis of 48 treatment comparisons resulting from 30 articles on enhancing self-regulated learning amongst primary school students. Based on recent models of self-regulated learning, which consider motivational, as well as cognitive, and metacognitive aspects [Boekaerts, M. (1999). Self-regulated learning: Where we are today. International Journal of Educational research, 31(6), 445–457], the effects of self-regulated learning on academic achievement, on cognitive and metacognitive strategy application, as well as on motivation were analyzed. As the results show, self-regulated learning training programmes proved to be effective, even at primary school level. Subsequent analysis tested for the effects of several moderator variables, which consisted of study features and training characteristics. Regarding factors that concern the content of the treatment, the impact of the theoretical background that underlies the intervention was tested, as well as the type of cognitive, metacognitive, or motivational strategy which were instructed, and if group work was used as instruction method. Training context related factors, which were included in the analyses, consisted of students' grade level, the length of the training, if teachers or researchers directed the intervention, as well as the school subject in which context the training took place. Following the results of these analyses, a list with the most effective training characteristics was provided.
Donker et al. 2014	In this meta-analysis the results of studies on learning strategy instruction focused on improving self-regulated learning were brought together to determine which specific analysis included 58 studies in primary and secondary education on interventions aimed at improving cognitive, metacognitive, and management strategy skills, as well as motivational aspects and metacognitive knowledge. A total of 95 interventions and 180 effect sizes demonstrated substantial effects in the domains of writing (Hedges' g = 1.25), science (.73), mathematics (.66) and comprehensive reading (.36). These domains differed in terms of which strategies were the most effective in improving academic performance. However, metacognitive knowledge instruction appeared to be valuable in all of them. Furthermore, it was found that the effects were higher when self-developed tests were used than in the case of intervention-independent tests. Finally, no differential effects were observed for students with different ability levels. To conclude, the authors have listed some implications of their analysis for the educational practice and made some suggestions for further research.
Haller et al. 1988	To assess the effect of "metacognitive" instruction on reading comprehension, 20 studies, with a total student population of 1,553, were compiled and quantitatively synthesized. For 115 effect sizes, or contrasts of experimental and control groups' performance, the mean effect size was .71, which indicates a substantial effect. In this compilation of studies, metacognitive instruction was found particularly effective for junior high students (seventh and eighth grades). Among the metacognitive skills, awareness of textual inconsistency and the use of self-questioning as both a monitoring and a regulating strategy were most effective. Reinforcement was the most effective teaching strategy.
Higgins et al. 2005	Executive Summary Methods: Relevant studies in the area of thinking skills were obtained by systematically searching a number of online databases of educational research literature, by identifying references in reviews and other relevant books and reports, and from contacts with expertise in this

	area. Twenty-six of the studies identified for this review were obtained from the database which resulted from the first thinking skills review (Higgins et al., 2004); a further three resulted from updating the original search and applying the more stringent criteria required for a quantitative synthesis. Studies were selected for the meta-analysis if they had sufficient quantitative data to calculate an effect size (relative to a control or comparison group of pupils) and if the number of research subjects was greater than 10. Effect sizes were calculated from the reported data and combined statistically using quantitative synthesis. Results: twenty-nine studies were identified which contained quantitative data on pupils' attainment and attitudes suitable for meta-analysis. The studies come from a range of countries around the world with half set in the US or UK. The studies broadly cover the ages of compulsory schooling (5–16) and include studies set in both primary and secondary schools. A number of named thinking skills interventions are included, such as Feuerstein's instrumental enrichment (FIE) and cognitive acceleration through science education (CASE) as well as studies which report a more general thinking skills approach (such as the development of metacognitive strategies). The quantitative synthesis indicates that thinking skills programmes and approaches are effective in improving the performance on tests of cognitive measures (such as Raven's progressive matrices) with an overall effect size of 0.62. (This effect would move a class ranked at 50th place in a league table of 100 similar classes to 26th or a percentile gain of 24 points.) However, these approaches also have a considerable impact on curricular outcomes with the same effect size of 0.62. The overall effect size (including cognitive, curricular and affective measures) was 0.74. Conclusions: Overall, the quantitative synthesis indicates that, when thinking skills programmes and approaches are used in schools, they are effective in improving pupils' performance on a range of tested outcomes (relative to those who did not receive thinking skills interventions). The magnitude of the gains found appears to be important when compared with the reported effect sizes of other educational interventions. This review found an overall mean effect of 0.62 for the main (cognitive) effect of each of the included studies, larger than the mean of Hattie's vast database of meta-analyses at 0.4 (Hattie, 1999) but very similar to the overall figure reported by Marzano (1998, p 76) of 0.65 for interventions across the knowledge, cognitive, metacognitive and self-system domains. In particular, our study identified metacognitive interventions as having relatively greater impact, similar to Marzano's study. Looking at a smaller part of our review, Feuerstein's instrumental enrichment is one of the most extensively researched thinking skills programme. Our results broadly concur with those of Romney and Samuels (2001), whose meta-analysis found moderate overall effects and an effect size of 0.43 on reasoning ability (p 28). Our findings were of the same order, with an overall effect size of 0.58 (one main effect from each of seven studies included) and an effect size of 0.52 on tests of reasoning (one main effect from four studies). There is some indication that the impact of thinking skills programmes and approaches may vary according to subject. In our analysis there was relatively greater impact on tests of mathematics (0.89) and science (0.78), compared with reading (0.4).
Klauer & Phye 2008	Researchers have examined inductive reasoning to identify different cognitive processes when participants deal with inductive problems. This article presents a prescriptive theory of inductive reasoning that identifies cognitive processing using a procedural strategy for making comparisons. It is hypothesized that training in the use of the procedural inductive

	reasoning strategy will improve cognitive functioning in terms of (a) increased fluid intelligence performance and (b) better academic learning of classroom subject matter. The review and meta-analysis summarizes the results of 74 training experiments with nearly 3,600 children. Both hypotheses are confirmed. Further, two moderating effects were observed: training effects on intelligence test performance increased over time, and positive problem solving transfer to academic learning is greater than transfer to intelligence test performance. The results cannot be explained by placebo or test-coaching effects. It is concluded that the proposed strategy is theoretically and educationally promising and that children of a broad age range and intellectual capacity benefit with such training.