International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Investigating The Effectiveness of Cognitive Learning Strategies for Learners: A Meta-Analysis

Dr. Kuldeep Kaur

Guest faculty, Department of Education, University of Allahabad

ABSTRACT

This research has been conducted to investigate the effectiveness of cognitive learning strategies for learners. For this purpose, meta-analysis method was used to synthesize the cognitive learning strategy intervention studies conducted in between 1986 and 2022. On the basis of pre-established systematic criteria, 70 articles were selected and 98 effect sizes were calculated. Cohen's d' formula was applied to calculate the effect size (Cooper & Hedges, 1994). The main objectives of the present study focus to find out the general effectiveness of the cognitive learning strategies, what kind of cognitive learning strategy is most effective and do the effect sizes of different types of cognitive learning strategies vary according to the applied domains, grade levels and achievement levels. The results of the study indicate that the overall cognitive learning strategies (98 ESs) yielded a large effect size (ESsm=.97) which was not homogenous (Q=56.08, $p < .05$). In each subcategory of learners' characteristics and applied domains, effect sizes were calculated and conducted the test of homogeneity separately. The effect sizes were generally homogenous in each subcategory except for grade level. The findings revealed that cognitive strategies had large effect sizes (.85-1.74). Cognitive learning strategies were very effective (.83-1.59) for average achieving students as well as underachieving students (with learning disabilities). The effect of cognitive learning strategies was analyzed very large in terms of students in all grades (1.09-1.40), except for middle school students (.78). Finally, the implications for the application of different cognitive learning strategies were discussed.

Key words: Cognitive learning strategy, meta-analysis, academic achievement

Introduction

We are living in the information age which is characterized by easy access of information and knowledge. In the present digital era, students must not only be able to find and navigate information but they also have to be competent to critically interpret that information. They ought to be able to express their ideas effectively. It demands the development of cognitive learning strategies to enhance the awareness of students' own strengths and to improve conscious control of learning. Cognitive learning strategies are the set of specific activities done by a learner for easier, more rapid, more effective and more transferable outcomes in new situations. Due to the lack of cognitive skills, children and adolescents face academic difficulties that are usually regarded as the most serious problem for them. In fact, many youngsters spend more time worrying about their schoolwork and grades than any other issue. In order to overcome the academic problems a considerable number of studies have been conducted to help students. Many correlates of both achievement and underachievement were systematically examined in the previous studies that include easy-to-control factors and hard-to-control factors. Intelligence, personality, learning strategy and cognitive learning strategy in particular was perceived as one of the significant controllable components for academic success unlike the hard-to-control factors. Sometimes, cognitive learning strategies which are composed of elaborate strategy, organized strategy, meta-cognitive strategy and affective strategy are considered as much the same as learning strategy (Weinstein and Mayer, 1986). To understand the learning strategies or study skills, Devine (1987) defined it as competencies associated with acquiring, organizing, synthesizing, remembering and using the information and ideas attained in school. Learning strategies are the organized procedures that students commence to complete various complex tasks as skimming, determining relevant information, taking notes along with study materials for a test (Kim, 1986; Jaleel, 2016).

The review of literature has presented a large number of strategies, ranging from extremely basic re-reading approaches to more complex methods of synthesizing knowledge or drawing conceptual frameworks. These learning strategies can be categorized in several ways i.e. cognitive, metacognitive and management strategies according to different taxonomies and classifications (e.g. Flavell, 1979; Weinstein and Mayer, 1986; Pressley, 2002; Mayer, 2008). Learning strategies comprises of the systematic techniques that involves the use of cognitive and metacognitive elements to respond autonomously to specific tasks (Deshler and Schumaker, 1986; Ellis, Lenz and Sabornie, 1987). Different taxonomies were also intended for the classification of learning strategies (Dansereau, 1985; Weinstein & Mayor, 1986; Pressley, 1986; McKeachie et al., 1991).

Many researches (Bos and Anders, 1990; Swanson, 1993; Swanson and Alexander, 1997; Stanovich and Siegel, 1994) observed that academic problems are significantly related to learning strategy deficits and initiated that learning strategy plays a major role in academic performance. Positive correlation has been often determined between learning strategies and academic performance (Alexander, Graham and Harris, 1998; Hattie et al., 1996; Weinstein, Husman and Dierking, 2000; Stanton et al., 2021). In addition, Karami (2002) analyzed that there is a correlation between learning strategies and academic achievement. From the previous studies, a great deal of evidence have identified that the students with academic difficulties lack the organizational and study skills that are needed to respond to the task provided in the regular classroom. The learners have also experienced difficulty in acquiring those skills. The students with academic difficulties are not actively involved in learning and illustrate deficiencies in spontaneous use of learning strategies. They were found passive in their approach to classroom tasks (Torgesen, 1982). The study of Chan and Cole (1986) observed that the students often did not recognize the need to apply a learned learning strategy in a new situation.

Cognitive learning strategies are a type of learning strategy that the learners use to increase the understanding of a certain domain. Such cognitive strategies include repetition, organizing new information, summarizing, draw meaning from context, using imagery for memorization. Cognitive learning strategies are found to be domain or even task-specific through which the students refer directly to the utilization of the information that are learned. Rehearsal, elaboration and organization strategies are distinguished as the three main subcategories of cognitive strategies (Pintrich, Smith, Garcia and McKeachie, 1991).

Efforts have been made to improve learning problems of the students by the use of specific cognitive strategies. According to the meta-analysis studies, providing training to the students with the application of cognitive learning skills has been proved successful. The particular study of Swanson and McMahon (1996) reported quantitative effect magnitude of learning strategies using the meta-analysis method. A total of 236 intervention research studies published between 1963 and 1995 were synthesized that entirely included students recognized with learning disabilities. The average effect size was about 0 .70. The findings addressed the effects of interventions on array of dependent measures including reading, writing, maths, creativity, social skills and perceptual domain. Further, Swanson and Hoskyn (1998) comprehensively synthesized experimental intervention studies from 1963 to 1997 that included students with learning disabilities. The effect sizes were calculated for 17 different categories such as memory, reading comprehension, writing, mathematics etc. Though, their previous analysis did not illustrate the relationship between targeted behaviors and treatment. Numerous studies have been conducted concerning the learning strategy programs and their overall effectiveness.

Weinstein and Hume (1998) have stated that teachers can assist their students through cognitive and metacognitive strategies (teaching, learning and studying skills) to be more successful learners and have more active roles in their academic affluence. What seems to be lacking in the preceding studies is the comprehensive and systematic summary of the research findings. However, it is not adequate just to recommend a wide array of learning strategies and their overall effects when we would like to help the teachers and learners to be more effective in teaching and learning. It is necessary to distinguish what strategies can be more effective when used upon whom and how to exercise these strategies. Shouse, Chen and Hsieh (2007) accentuated the importance of preparing the educational system compatible with learning methods of students in schools. Thus, the compatibility of educational material with students' cognitive styles can help them to access better achievements and motivation. In addition, McKeachie et al. (1991) proposed a teaching and learning model and find out that learning behavior is directly influenced by learner's cognition and motivation (Wolters and Hussain, 2015). This signifies the consideration of learners' intrapersonal conditions and characteristics while pertaining to the learning strategies for learners. Kim (1998) examined Piaget's cognitive development theory to find out learners' thinking across different grade levels and concluded that not all the strategies can be used by all learners. In fact, these theoretical ideas have not been verified empirically in the field of learning strategy instruction that is required to be done for educational practice. Several studies have mainly offered immediate effects of the cognitive learning strategies program in accordance with the variables consisting cognitive ability, academic achievement, efficacy of using learning strategies and general affective domains (Kim et al., 2002).

In this study, the effect sizes of subcategories of cognitive learning strategies are clarified to apply efficiently in practice. By integrating and comparing the findings of related studies, researchers strived to capture general patterns among diverse studies on similar topic. It helps to potentially identify the robust relationships between learners and appropriate learning strategies. Students can learn the appropriateness of cognitive strategies effectively in time-bound situations. The main purpose of this study was to provide a comprehensive quantitative synthesis of studies related to cognitive learning strategies that focused on intervention to improve students' academic performance. This study

conducted to find out the effectiveness of cognitive learning strategies generally, Type of cognitive learning strategy which is most effective and variations in the effect sizes of different types of cognitive learning strategies differ with the applied domains, grade levels and achievement levels.

Methodology

For meta-analysis, sample group for this research comprised of online literature searches that were carried out to find relevant articles in the peer-reviewed journals from 1986 to 2022. The inclusion criteria for selecting research required studies that include the terms learning strategy, cognitive strategy, meta-cognitive strategy and strategy education. From this initial pool of identified studies, selection criteria comprised of following stages:

(i) In the first stage, the identified studies incorporated the learning strategies and outcome measures.

(ii) Second stage of the research included the identified studies limited to only those studies that compare learning strategy treatment groups with control groups.

(iii) Result of the studies must report effect sizes obtainable to meet the following criteria: the study must report (a) means and standard deviation of each group or (b) test statistics such as z-value, t-value or F-value. Finally, 70 studies were identified that met the criteria to be included in the meta-analysis.

For coding purpose, a form was developed that included (i) the study information i.e. authors, year in which paper was published and a title, (ii) Subject characteristics i.e. demographic data including grade level, academic achievement, gender and sample size, (iii) Intervention dimensions viz. the categories of learning strategies, number of sessions, (iv) The categories of applied domains and calculated effect sizes.

Further, the classification of cognitive leaning strategies was accomplished on the basis of Weinstein and Mayer (1986) study as elaborate strategy (involved the strategy to assimilate prior knowledge with current information), organized strategy (mnemonic skills to categorize academic contents and items or make them hierarchical array), meta-cognitive strategy (related to planning, regulating, monitoring and modifying cognitive processes), affective strategy (concerned the students' strategies to facilitate their motivation or to relieve the tension to overcome test anxiety) and combined strategy (if the intervention in the target article was composed of more than two types of learning strategies).

Based on the dependent variables of target article cognitive ability, academic achievement, efficacy of using learning strategies and general affective domain were identified as categories of applied domains. The present study carried out to find out the academic achievement level of learners. Sample included underachievement students with learning disabilities whose academic achievement was far lower than their potential ability. While remaining students were classified as average achievement students. All of the studies were coded by two coders independently. To indicate the reliability of the coding procedures, the Intercoder consistency was examined. Cohen's Kappa method was used to calculate the interrater reliability which was found .83.

Table 1
Coding categories

Categories		Subcategories
Study Information		Title, author(s), published year
Characteristics of the sample	Grade level	Elementary school (9yr.), middle school (8yr.), high school (6yr.), college (2-9yr.)
	Academic achievement level	Underachievement student and average achievement students with learning disabilities
	Gender	Male, female
	Sample size	Sample size of treatment and non-treatment group
Intervention Dimensions	Sub-types of Learning Strategies	Elaborate strategy, organized strategy, meta-cognitive strategy, affective strategy and combined strategy
	Number of Sessions	Under 6 sessions, 7-11 sessions, 12-16 sessions, 17-22 sessions, 23-27 sessions, over 28 sessions
Dependent Measures	Categories of applied domains	Cognitive ability, Academic achievement, efficacy of using learning strategies and general affective domain

Calculation of Effect size

Calculation of effect size done by the general procedures in the following steps: (1) The effect sizes were calculated within a study and aggregating across studies, (2) Homogeneity of the aggregating effect size was tested, (3) Confidence interval was examined to verify whether overall effect size contain zero. In this meta-analysis, Cohen's d (Cooper & Hedges, 1994) was used as the effect size index for the comparison between two means. Effect size (g) was calculated as the mean of the treatment group posttest score minus the mean of the comparison group posttest score divided by the pooled standard deviation i.e.

$$g = (M_A - M_B) / S_D \qquad (1)$$

where,

g = Effect size obtained from comparison of groups in a study

M_A and M_B = Means for the variables for treatment group A and control group B respectively

S_D = Pooled SD

Effect sizes were calculated for each treatment group and associated dependent variables. The pooled standard deviation was calculated as signified in Cooper and Hedges (1994). Further, the unbiased estimates of the population effect size (d) were estimated by correcting (approximately) the bias in *g* (Hedges and Olkin, 1985) which is as follows:

$$d = [(1-3)/(4N-9)]g \qquad (2)$$

$$N = \text{nA+nB}$$

where

n = Number of participants

N = Sum of the number of participants in Treatment A and in non-treatment B

The variance of d was calculated by

$$\delta^2\,(\text{d}) = [N/(n_A n_B)] + [d^2/2N] \qquad (3)$$

The effect sizes were not considered independent when two or more effect sizes were produced in a single article. In such a case the Equations (4) and (5) were used to aggregate the effect sizes as given below:

$$d_C = [\Lambda e / e'\Lambda e]d_i \qquad (4)$$

Along with an estimated variance of

$$\delta^2\,(d_C) = 1/e'\Lambda e \qquad (5)$$

The above-mentioned equations are the methods used to form an aggregated effect sizes for several dependent measures used in the target articles analyzed (Hedges and Olkin, 1985). The estimates produced by equations (4) and (5) were used in all of the subsequent analysis.

To determine the estimated aggregate effect size, the following formula was used:

$$d_C - agg = \left[\sum_{i=1}^{k} \frac{d_{Ci}}{\delta^2(d_{Ci})}\right] \Big/ \left[\sum_{i=1}^{k} \frac{1}{\delta^2(d_{Ci})}\right] \qquad (6)$$

where

dc-agg = Aggregate of the set of the values of effect sizes weighted by the inverse of variance,
dci = The estimated effect size for comparison I
k = Number of effects aggregated

The estimate of the variance of this aggregate is calculated by

$$\delta^2(d_C - agg) = \left(\sum_{i=1}^{k} \frac{1}{\delta^2(d_{Ci})} \right)^{-1} \quad (7)$$

Homogeneity of variance was tested by applying Chi-square test (Q-test). The effect sizes could be described in the same way as a Z-score. An effect size of +1.00 indicates that the performance of the experimental group exceed the control group's performance on the dependent measure by one standard deviation. A negative effect size indicates the superior performance of the control group than the experimental group. Cohen's (1988) distinctions on the magnitude of the effect sizes were used for the purpose of interpretation. Here, .23 in absolute value is a small size, .54 is of moderate size, and .85 is a large effect size. To interpret the effect size more meaningfully researcher has offered standing percentiles (U3). Additionally, effect size was assessed from its 95% confidence interval and its statistical significance was determined at this level. If the confidence interval doesn't include zero then the positive mean effect is significantly different from zero ($p < .05$).

Results

The results of the present study described in the following steps:

(i) Description of the identified studies

For the purpose of meta-analysis, the literature search identified 70 different articles that met the inclusion criteria. 96 different effect sizes were computed from these 70 target articles. Among 70 articles that reported the effects of learning strategies, three study contained the primary level (Grade 1 through Grade 3) of elementary students, twenty-five studies involved the intermediate level (Grade 4 through Grade 6), twelve studies were for middle school students, seven studies involved high school and four studies were focused on college students. Majority of the articles were drawn from intermediate level of elementary schools and middle schools. As for the achievement level of the learners in the studies, the majority (49, 81.3%) of the studies involved the average achievement students and the rest of them (21, 18.7%) involved the underachievement students (with learning disabilities).

The estimated aggregate effect size was .98 and as a result of Q-test analysis, it was found to be not homogenous ($Q = 59.13$, $p < .05$). Thus, in each subcategory of learners' characteristics and applied domains effect sizes were calculated and the tests of homogeneity were conducted.

(ii) Effect sizes of subtypes of Cognitive learning strategies

Table 2
Effect sizes of subtypes of Cognitive learning strategies

	Number of studies	Number of Effect Size (ES)	Mean ES	SD of Mean Effect Size	U3 (%)	CI (95%)	
						Lower	Upper
Elaborate strategy	15	12	.95	.84	82.38	.40	1.46
Organized strategy	13	14	.46	.30	67.36	.28	.62
Combined strategy	8	20	1.19	.82	87.08	.74	1.51
Meta-cognitive strategy	29	43	1.04	.95	85.08	.74	1.34
Affective strategy	5	9	1.10	1.64	86.43	.17	2.36
Total	70	98	.97	.10	83.15	.77	1.16

Table-2 represents the values of effect sizes of subtypes of cognitive learning strategies. The second column of Table-2 shows a wide range of the variation of the number of effect size of each learning strategy. Categories involved were meta-cognitive strategy (29, 47.0%), elaborate strategy (15, 24.0%) and organized strategy (13, 19.8%). The effect sizes were found significant and homogenous. Organized strategy produced the moderate effect sizes (.46). In general, the effect sizes of subcategories of cognitive learning strategies were observed as large enough (.95-1.19).

(iii) Effect sizes by applied domains of learning strategies

The number of studies of the applied domains reported in Table 3:

Table 3
Number of studies of applied domains

Applied domains	1	2	3	4	1,2	1,4	2,3	2,4	3,4	1,2,4	1,3,4	2,3,4	Total
Number of studies	9	25	1	4	1	10	7	3	1	2	4	3	70

Percentage (%)	10.0	37.0	2.0	4.0	2.0	16.0	8.0	6.0	2.0	2.0	6.0	5.0	100

1. Academic achievement, 2. Cognitive ability, 3. Efficacy of using learning strategies, 4. General affective domain

As shown in Table 3, the applied domains of learning strategies (dependent variables in the target articles) were classified into four categories: academic achievement, cognitive ability, efficacy of using learning strategies and general affective domain. Cognitive ability (37.0%) was examined the most frequent applied domain followed by academic achievement (10.0%) and general affective domain (4.0%).

Table 4
Effect sizes of the applied domains

Applied domains	Number of Effect Size	Mean Effect Size	SD of Mean Effect Size	U3 (%)	CI (95%)	
					Lower	Upper
Academic achievement	22	.96	1.18	83.15	.42	1.50
Efficacy of using learning strategies	12	1.70	1.24	96.49	.91	2.46
Cognitive ability	40	.85	.83	79.80	.57	1.09
General affective domain	24	.83	.12	79.67	.58	1.07
Total	98	.97	.15	84.15	.77	1.16

Table 4 represented the effect sizes of the applied domains. None of confidence interval (CI) of the mean effect sizes of all applied domains contain zero. Therefore, a null hypothesis was rejected. Among all the categories of applied domains, the cognitive learning strategies were found very effective. The effect sizes were identified as large enough (.85-1.70).

(iv) Effect sizes obtained by student grade levels

Here, the mean effect sizes of learning strategies were analyzed according to the students' grade levels.

International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Table 5
Mean effect sizes of learning strategies by grade levels

Grade Level	Cognitive learning strategy	Number of effect size	Mean effect size	SD of Mean effect size	U3 (%)	CI (95%)	
						Lower	Upper
Primary grade level of elementary school	Meta-cognitive strategy	4	.86	.27	80.23	.20	1.69
Intermediate grade level of elementary school	Elaborate Strategy	5	1.19	.45	88.30	.05	2.43
	Organized Strategy	6	.53	.17	70.19	.08	.98
	Meta-cognitive strategy	18	1.19	.22	88.10	.71	1.66
	Affective strategy	3	1.82	.78	96.56	.29	3.35
	Combined strategy	5	1.37	.68	75.17	.52	3.26
Sub Total		37	1.16	.20	87.49	.77	1.16
Middle school	Elaborate Strategy	7	.74	.27	77.04	.07	1.41
	Organized Strategy	7	.38	.06	64.80	.23	.53
	Meta-cognitive strategy	13	.58	.19	71.90	.17	.99
	Affective strategy	4	.74	.14	77.04	.29	1.19
	Combined strategy	9	1.07	.20	85.54	.60	1.53
Sub Total		40	.70	.10	75.80	.51	.89
High school	Organized strategy	1	.49	.00	68.79	*	*
	Meta-	8	1.60	.47	94.52	.50	2.71

	cognitive strategy						
	Affective strategy	2	.72	.05	76.42	*	*
Sub Total		11	1.35	.36	90.99	.54	2.14
College	Combined strategy	6	1.02	.11	84.61	.75	1.29
Total		98	.96	.10	83.15	.77	1.16

* Due to the limited sample size ($n < 3$), the CI was not calculated.

Table 5 illustrated the mean effect size of each cognitive learning strategy. For all the grade levels, the effect sizes were generally large but not homogenous. Except for middle school students, the overall effect of cognitive learning strategies was quite large for the students in all grades (.86-1.35). A moderate effect size (.70) was obtained for middle school. The values in the Table 5 indicated that all subtypes of cognitive learning strategies produced relatively large effect sizes except organized strategy for the intermediate level (Grade 4-6) of elementary school students. In the case of middle school students, combined strategy showed large effect sizes (1.07) while the other strategies produced moderate results in their effect sizes. Meta-cognitive strategy and combined strategy yielded large effect sizes (1.60, 1.02) for high school and college students.

(v) Mean effect sizes by applied domains and grade levels

On the basis of grade levels, the effect sizes of applied domains were shown in Table 6. The effect sizes of applied domains were found non homogenous. Across the grade levels, cognitive learning strategies were comprehensively used in four applied domains. It generally yielded large effect sizes. For the primary grade level of elementary school students, the learning strategies applied to academic achievement produced the moderate effect sizes (.52) while the learning strategies applied to general affective domain was very effective (1.19). However, further studies were in order due to the small sample size. The learning strategies were very effective in all domains for the intermediate level of elementary school students. Especially in terms of learning strategies when applied to efficacy of using learning strategies and academic achievement yielded the very large effect sizes (1.98, 1.54).

In the case of middle school students, large effect sizes (1.25) were produced when the learning strategies applied to efficacy of using learning strategies while the learning strategies applied to the other domains yielded moderate effect sizes. For high school students, the learning strategies produced large effect sizes when applied to the efficacy of using learning strategies, general affective domain and academic achievement. In addition, the effect sizes of learning strategies applied to cognitive ability were moderate (.46). For college students, the learning strategies were generally very effective. Nevertheless, precaution should be taken while interpreting the result in of the case limited sample size of the studies.

International Journal for Multidisciplinary Research (IJFMR)

E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Table 6

Mean effect sizes by applied domains and grade levels

Grade Level	Applied Domains	Number of effect size	Mean effect size	SD of Mean effect size	U3 (%)	CI (95%)	
						Lower	Upper
Primary grade level of elementary school	Academic achievement	3	.52	.35	69.50	*	*
	General affective domain	2	1.19	.25	88.30	*	*
Intermediate grade level of elementary school	Academic achievement	6	1.54	.84	93.94	.60	3.70
	Cognitive ability	20	1.02	.22	84.61	.56	1.49
	Efficacy of using learning strategies	3	1.98	.60	97.56	.80	3.15
	General affective domain	6	.80	.11	78.81	.53	1.07
Middle school	Academic achievement	10	.75	.20	77.34	.30	1.20
	Cognitive ability	14	.63	.14	73.57	.32	.93
	Efficacy of using learning strategies	5	1.25	.37	89.25	.21	2.27
	General affective domain	11	.49	.14	68.79	.18	.80
High school	Academic achievement	2	.83	.06	79.67	*	*
	Cognitive ability	4	.46	.10	67.36	.14	.76
	Efficacy of using learning strategies	2	3.18	.97	99.93	*	*

	General affective domain	3	1.65	.50	95.05	.51	3.81
College	Academic achievement	1	.74	.00	77.04	*	*
	Cognitive ability	1	1.36	.00	91.31	*	*
	Efficacy of using learning strategies	2	.93	.18	82.38	*	*
	General affective domain	2	1.13	.14	87.08	*	*
Total		98	1.09	.22	85.31	.62	1.48

* Due to the limited sample size (*n* < 3), the CI was not calculated.

(vi) <u>Effect sizes by achievement level</u>

Mean effect sizes of cognitive learning strategies by means of achievement level represented in table 7:

Table 7
Mean effect sizes of cognitive learning strategies by achievement level

Achievement level	Cognitive learning strategies	Number of Effect Size	Mean Effect Size	SD of Mean Effect Size	U3 (%)	CI (95%)	
						Lower	Upper
Average achievement student	Elaborate strategy	9	.79	.30	78.52	.09	1.48
	Organized strategy	14	.45	.08	67.36	.28	.62
	Meta-cognitive strategy	32	.88	.15	81.06	.57	1.18
	Affective strategy	7	1.26	.70	89.62	.45	2.98
	Combined strategy	12	.88	.12	81.06	.62	1.15
Sub Total		74	.82	.10	79.39	.62	1.02

Under-achievement student	Elaborate strategy	3	1.36	.29	91.31	.01	2.62
	Meta-cognitive strategy	10	1.56	.36	94.06	.74	2.37
	Affective strategy	2	.51	.06	69.50	.22	1.24
	Combined strategy	8	1.50	.41	93.32	.54	2.45
Sub Total		23	1.43	.21	92.22	1.01	1.83

The above table 7 provided the effect size of each cognitive learning strategy for both average achievement students as well as underachieving students (with learning disabilities). The effect sizes of achievement level were found homogenous. Cognitive learning strategies were applied more frequently for average achievement students. Overall for both groups of students, the effect sizes of cognitive learning strategies yielded large effect sizes.

Afterwards, the effect sizes and mean effect sizes were calculated according to applied domains and achievement level as shown in Table 8:

Table 8
Mean effect sizes of applied domains by Achievement Level

Achievement level	Applied domains	Number of Effect Size	Mean Effect Size	SD of Mean Effect Size	U3 (%)	CI (95%)	
						Lower	Upper
Average achievement student	Academic achievement	17	.95	.32	82.89	.28	1.62
	Cognitive ability	34	.66	.11	74.54	.44	.87
	Efficacy of using learning strategies	7	1.57	.42	94.18	.53	2.61
	General affective domain	16	.70	.12	75.80	.45	.95
	Academic	4	1.01	.26	84.38	.20	1.82

	achievement						
Under-achievement student	Cognitive ability	6	1.77	.48	96.16	.54	3.01
	Efficacy of using learning strategies	5	1.86	.65	96.86	.05	3.67
	General affective domain	8	1.08	.26	85.99	.47	1.69

Table 8 indicated that the effect sizes of achievement level were not homogenous. Cognitive learning strategies were extensively used in four applied domains across the academic level and also yielded generally large effect sizes.

Discussion and conclusion

The findings of this study revealed that the overall cognitive strategies (98 ESs) yielded a large effect size (.97). It implied that the mean of the treatment group was located on the .84 percentile in the normal curve distribution of control group. On the other hand, the aggregated effect sizes were not homogenous. Therefore, effect sizes were calculated and homogeneity in each subcategory of cognitive strategies was tested. Apart from grade levels, the effect sizes turned out to be homogenous in each subcategory. It reflected that the differences of effect sizes of cognitive learning strategies were not significant.

The results revealed that cognitive strategies had a significantly large effect size (.95-1.19). Likewise, cognitive learning strategies were observed very effective for both average achieving and underachieving students (.82-1.43). Except for middle school students, the effect of cognitive learning strategies was very large for students in all grades (1.02-1.36). The effect size for middle school students had a moderate value (ESsm = .78).

This study focused on the cognitive learning strategy and the findings turned out to be alike to the previous study of Kim, Shin and Hwang (2002). For all grade levels, cognitive learning strategies were found to be effective. The effect sizes among grade levels were not homogenous. It indicated the effect sizes among grade level could be different. Although the effect sizes of cognitive learning strategies for middle school students were still moderate but in general cognitive learning strategies were quite effective. Elaborate strategy used after middle school ages regarded to be voluntarily as a cognitive learning skill. Considering the complexity of connecting two or more items of information, it could enhance the learner's ability to integrate the meaning of given information with the background knowledge (Pressley, 1986; Song, 2000, Dike, 2017).

Moreover, the results indicated that all of the subtypes of cognitive learning strategies were effective interventions in the applied domains for both average achieving students and those with learning disabilities. Also, a strong positive effect size was found on the effectiveness of metacognitive interventions which is related to the findings of Venkateswar et al. (2021). Therefore, it is necessary to emphasize researches on learner's cognitive developmental stages. The findings suggested that learners at the intermediate grade level of elementary school could adopt cognitive learning strategies competently as well as voluntarily.

Further, the efforts were also made to analyze the reasons why the effect sizes for middle school students were smaller than the other grade levels. This finding suggested that early interventions of learning strategies at the elementary level might be very helpful later on and related to the study of Gutierrez de Blume (2022). Given the small number of subjects in the lower elementary school and college students, one must be cautious in drawing any broad conclusions. To sum up, the results of the study has drawn the following implications: Initially, this study confirms that most of the cognitive learning strategies can be applied to different subject matter and effective across a range of diverse learners. Subsequently, early interventions using learning strategies could be very effective and it is a recommended practice for both teachers and students.

References

1. Bae, J. & Park, H. (2001). The effect of schema based cognitive-metacognitive strategy instruction on solving instruction on solving mathematical word problems for students with mathematical learning disabilities. *The Journal of Special Education*, 36 (3), 1-20.
2. Gutierrez de Blume, A. P. (2022). Calibrating calibration: a meta-analysis of learning strategy instruction interventions to improve metacognitive monitoring accuracy. *J. Educ. Psychol.*, 114, 681–700.
3. Bos, C. S. & Anders, P. L. (1990). Effects of interactive vocabulary instruction on the vocabulary learning and reading comprehension of junior-high learning disabled students. *Learning Disability Quarterly*, 12 (1), 31-42.
4. Byun, H., & Ryu, H. (1995). The effects of elaborative interrogation and prior-knowledge on learning of facts. *Educational Review in Chonbuk University*, 40, 1-13.
5. Chan, L. K. S. & Cole, P. G. (1986). The effects of comprehension-monitoring training on the reading competence of learning disabled and regular class students. *Remedial and Special Education*, 7, 33-40.
6. Choi, C (1996). The effects of the semantic networking learning strategies on the structural knowledge in the hypertext learning environment. *Research in Educational Psychology*, 10 (2), 261-285.
7. Choi, B. (1999). Effects of teacher-directed strategies instruction and interactive strategies instruction on reading comprehension, metacognition and self efficacy of students with learning disabilities. *The Journal of the Research Institute of Korean Education*, 12, 51-73.
8. Choi, S. (2001). Effects of attributional training using cognitive and metacognitive strategies on attribution, emotion and mathematical word problem solving. *The Journal of Special Education*, 8 (2), 195-220.

9. Choi, S. (2002). The effects of strategy training on the mathematical word problem solving and self-efficacy of middle and high school students with learning disabilities. *The Journal of Special Education*, 9 (1), 221-239.
10. Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). New York: Academic Press.
11. Cooper, H. & Hedges, L. V. (1994). Research synthesis as a scientific enterprise. In H. Cooper & L. V. Hedges (Eds.), *The handbook of research synthesis*. New York: Russell Sage Foundation, pp. 3-16.
12. Dansereau, D. F. (1985). Learning strategy research. In J. Segal, S. Chipman, & R. Glaser (Eds.), *Thinking and learning skills: Relating instruction to research* (Vol. 1). Hillsdale, NJ: Erlbaum.
13. Deshler, D. D. & Schumaker, J. B. (1986). Learning strategies: An instructional alternative for lowachieving adolescents. *Exceptional Children*, 52 (6), 583-590.
14. Devine, T. G. (1987). *Teaching study skills: A guide for teachers* (2nd ed.). Boston: Allyn & Bacon.
15. Dike, J. W., Mumuni, A. A. O. & Chinda, Q. (2017). Metacognitive teaching strategies on secondary school students' academic performance. *International Journal of Computational Engineering Research (IJCER)*, 7 (1), 14-20.
16. Ellis, E. S., Lenz, B. K. & Saborine, E. J. (1987a). Generalization and adaptation of learning strategies to natural environments: Part 1: Critical agents. *Remedial and Special Education*, 8 (1), 6-20.
17. Ellis, E. S., Lenz, B. K. & Saborine, E. J. (1987b). Generalization and adaptation of learning strategies to natural environments: Part 2: Research into practice. *Remedial and Special Education*, 8 (2), 6-23.
18. Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of psychological inquiry. American Psychologist, 34, 906-911.
19. Han, O. & Park, H. (1997). The effects of problem-solving learning applied strategic problem-posing on the achievement in mathematics. *Proceedings of Mathematical Education*, 6, 337-356.
20. Han, S. (1997). The effect of reading strategy, metacognition, motivation on text comprehension. *The Journal of Educational Research*, 35 (1), 83-104.
21. Hedges, L. V. & Olkin, I. (1985). *Statistical methods for meta-analysis*. Orlando: Academic Press.
22. Hwang, H. (1994). The effect of metacognitive learning strategy on its application and reading comprehension. *The Journal of Educational Research in Pusan*, 7 (12), 127-157.
23. Hwang, B. (1998). The effects of the concept mapping as an instructional strategy in geography education- An experiment for the instructional unit of urban geography. *The Journal of Geography Education*, 39, 1-15.
24. Hwang, H. (1999). Developing learning strategy program and its' effect on academic achievement for college students. *Journal of Student Guidance Research*, 10 (1), 7-24.
25. Hwang, H. (2001). The effects of embedding approach for the improvement of critical thinking ability. *The Journal of Educational Research*, 39 (3), 187-214.
26. Jeon, S. & Kim, Y (2001). Effects of instruction of volition strategies on academic achievement, self-efficacy of social studies. *Research in Educational Psychology*, 15 (4), 463-480.

27. Jaleel, S. (2016). A study on the metacognitive awareness of secondary school students. *Univ. J. Educ. Res*,. 4, 165–172.
28. Kang, B. (2001). The effects of the cognitive level based constructive instruction - learning strategies on the problem-solving abilities in the hypermedia learning environment. *The Journal of Educational Research*, 19 (3), 285-312.
29. Kang, B. (2003). The effects of situation-based instruction strategies on children's academic attitude and achievement of natural science. *The Journal of the Research Institute of Korean Education*, 18, 101-114.
30. Kang, H., Ha, J. & Kim, N. (1996). The effects of learning through concept mapping on elementary school science achievement and creativity. *Elementary Science Education*, 15 (2), 191-206.
31. Kang, K. & Lee, J. (1999). The Effects of Elaboration on Memory. *Educational Psychology Research*, 3 (1), 1-20.
32. Kil, H. & Baek, S. (1997). The effects of metacognition strategy on the conceptual change of mass conservation. *Chemical Education*, 24 (4), 187-201.
33. Kim, A. (1996). The effects of metacognition training on children's attributional style and ability of solving problem. *The Journal of Educational Research*, 10 (2), 25-52.
34. Kim, D. (1998). Counseling on the academic development. *Encyclopedia on Education*, Seoul: Hawoo.
35. Kim, D., Shin, E. & Hwang, A. (2002). A meta analysis on learning strategy. *Asia Journal of Education*, 7 (3), 53-76.
36. Kaur, K. (2017). Influence of demographic factors on metacognition and its relationship with critical thinking of higher secondary students: Foundation for learning. *International Journal for Research in Applied Science & Engineering Technology (IJRASET)*, 5 (7), 358–363.
37. Kim, J. (2004). The impact of cognitive strategy-based instruction on student achievement. *Journal of KAHPERD*, 43 (3), 229-243.
38. Kim, Y. (1996). The effects of self-regulating strategy instruction and metacognition on children's writing performance. *The Journal of Educational Research*, 34 (5), 97-119.
39. Kim, Y. (1998). The effects of mind mapping note method on the memory and understanding of children. *The Journal of Educational Research*, 36 (4), 281-308.
40. Kim, Y., Shin, S. & Lee, S (2003). The study on the effect of concept maps teaching strategy on the elementary school children. *Journal of research in Science Teaching*, 27, 115-127.

41. Kwak, N., Park, H. & Kang, B. (2000). The effects of constructivist instruction strategies on children academic attitude and self-efficacy of natural science. *The Journal of Korea elementary education*, 42, 339-362.
42. Lee, E. (1997). The effect of graphic organizer strategy map on reading. *The Society of Chongnan Language & Literature*, 19, 123-149.
43. Lee, J. (1995). Effects of learning strategies training on mathematics achievement, self-regulation, impulsivity, and self-efficacy of the learning disabled. *The Journal of Educational Research*, 33 (3), 179-205.

44. Lee, J. (1996). The effects of self-instruction and attributional training on mathematics achievement and self-efficacy of middle school students with learning disabilities. *The Journal of Educational Research*, 34 (5), 233-254.
45. Lee, J. (2000). The effects of transactional comprehension strategies instruction on children's reading comprehension metacognition. *The Journal of Educational Research in Pusan*, 13 (1), 21-48.
46. Lee, J. & Heo, M. (1995). The effect of concept map on the attitude of science class and academic achievement. *Journal of the Korean Association for Research in Science Education*, 15, 223-232.
47. Lee, M. (2000). The effect of learning strategy on the strategy application and self- efficacy of underachiever. *Student Guidance Center in Chongju National University of Education*, 8, 80-90.
48. Lee, S. (2002). The achievement level effects of constructivism instructional design on mathematics achievement and learning attitude. *Research in Educational Psychology*, 16 (1), 123-139.
49. Mckeachie, Wilbert J., Pintrich, P. R., Lin. Y. & Smith, D. A. F. (1991). Teaching and learning in the college classroom. *Review of the Research Literature*. University of Michigan: MCRITAC.
50. Meher, V., Baral, R. & Bhuyan, S, (2021). A Meta-Analysis on the Effectiveness of Metacognitive Strategies and Interventions in Teaching and Learning Process. *Journal on Educational Psychology*, 14 (4), 47-58.
51. Moon, S. & Bae, H. (1995). Effects of text structure/summarization training on expository text processing. *The Journal of Education Research*, 33 (5), 21-43.
52. Moon, B. (2000). The effects of self regulated learning strategy training on children`s academic performance. *The Journal of Education Research*, 20 (2), 61-76.
53. Park, Y. & Choi, B. (2003). Effect of reading strategy instructions on metacognition and reading comprehension. *Research in Educational Psychology*, 17 (1), 167-186.
54. Pressley, M. (1986). The relevance of the good strategy user model to teaching of mathematics. *Educational Psychologist*, 21, 39-161.
55. Shim, H. & Jung, J. (2003). The effects of self-regulated learning strategy training for reading underachievers in elementary school. *Educational Development Review*, 24 (1), 105-134.
56. Song, M. (2000). *Developmental psychology*. Seoul: Hakjisa.
57. Stanovich, K. E. & Siegel, L. S. (1994). The phenotypic performance profile of reading-disabled children: A regression-based test of the phonological-core variable difference model. *Journal of Educational Psychology*, 86, 24-53.
58. Stanton, J. D., Sebesta, A. J., & Dunlosky, J. (2021). Fostering metacognition to support student learning and performance. CBE Life Sci. Educ., 20, 1–7.
59. Swanson, H. L. (1993). Working memory in learning disability subgroups. *Journal of Experimental Child Psychology*, 56, 87-114.
60. Swanson, H. L. & McMahon, C. M. (1996). *Synthesis of intervention research for students with learning disabilities*. Unpublished paper, University of California-Riverside.
61. Swanson, H. L. & Alexander, T. E. (1997). Cognitive processes as predictors of word recognition and reading comprehension in learning-disabled and skilled readers: Revisiting the specificity hypothesis. *Journal of Educational Psychology*, 89 (1), 128-158.

62. Swanson, H. L. & Hoskyn, M. (1998). Experimental intervention research on students with learning disabilities: A meta-analysis of treatment outcomes. *Review of Educational Research*, 68, 277-321.
63. Torgesen, J. K. (1977). Memorization processes in reading disabled children. *Journal of Educational Psychology*, 69, 571-578.
64. Torgesen, J. K. (1982). The learning-disabled child as an inactive learner: Educational implications. *Topics in Learning and Learning Disabilities*, 2, 45-52.
65. Weinstein, C. E. & Mayer, C. (1986). The teaching of learning strategies. In M. C. Wittrock (Ed.), *Handbook of research on teaching*, American Education Research Association.
66. Wolters, C. A. & Hussain, M. (2015). Investigating grit and its relations with college students' self-regulated learning and academic achievement. *Metacogn. Learn.*, 10, 293–311.