



# A Systematic Evaluation and Meta-Analysis of the Effect of Metacognitive Intervention in Physical Education Teaching

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**Abstract.** This study aims to explore the positive effect of metacognitive intervention on students' physical education learning, and explore its moderating effect on students' physical education learning. By means of literature study and statistical processing, 32 relevant literatures were screened and meta-analyzed according to PICOS principle. The results showed that: (1) metacognitive intervention had significant effects on skill test scores, metacognitive ability and metacognitive strategies.

**Keywords:** metacognition · Physical education · Meta-analysis · Sports events · Systematic evaluation

## 1 Introduction

Metacognition, or metacognition, is a new concept proposed only in the last 50 years. In 1956, FredTarski first proposed “Meta”, that is, “meta”. Flavell summarized the philosophical thought and concept, and defined metacognition as “knowledge or behavior that can reflect or regulate any kind of cognitive behavior. That is, the knowledge of knowledge”. The metacognitive process is actually a kind of guidance and regulation of our cognitive process, and the control and implementation process of selecting effective cognitive strategies, whose essence is people's self-awareness and self-control of cognitive activities [1]. In recent years, more and more scholars have studied it from different angles. VonWright defined metacognitive ability as the measures taken by people to regulate their own cognitive and behavioral processes, and to cultivate metacognitive ability is to acquire those procedures to regulate cognitive processes [2]. It is a process that runs through the entire problem discovery process, and it is regulated in each process. The classroom is a very complex place, where many factors interact, thus affecting students' thinking and learning. Like a lot of clinical research on learning and metacognition, it may not always fit. Moreover, teachers play a very important role in determining the rules, habits and tools of the classroom activity system. The way to improve teaching, therefore, may well be to change the classroom learning area and the rules and customs of interaction associated with it. In addition, some studies have shown that there may be interaction and interaction between metacognitive level and cognitive

level, and the effect of metacognitive intervention teaching will also be interfered by differences in learning disciplines [18]. The role of metacognitive intervention in physical education teaching is still inconclusive. At present, the empirical research of physical education in Chinese universities is not much, mainly because the selection of sports item is limited, and the particularity of sports technology. This study uses the method of meta-analysis to explore the effect of metacognition intervention on physical education teaching, specifically including: (1) Compared with traditional teaching methods (teachers demonstrate technical movements and students imitate), whether metacognitive intervention has a positive effect on physical education teaching, including learning performance and metacognition-related abilities, etc. (2) What is the relationship between the effects of metacognitive intervention on learning outcomes and different learning segments, different sports and different intervention strategies?

(3) Which metacognitive intervention strategies have the greatest effect on students' academic performance? Which factor has the greatest effect on metacognition?

## 2 Research Strategies

### 2.1 Literature Search

Using the general statistical method of biblioinformatics, the search was carried out in the databases of China National Knowledge Network, database, database and so on. EBSCO Psychological Information Resource Database (PA&PBSC) and WOS (as of June 2020) were used as search platforms. In the retrieval of Chinese literature on CNKI, metacognitive keywords such as “metacognitive”, “metacognitive knowledge”, “metacognitive experience”, “metacognitive monitoring”, “education”, “teaching” and “sports” are used as “metacognitive” to conduct comprehensive retrieval. Using the EBSCO Psychological Data Bank (United States Center for Public Health and Public Health Services) to retrieve English documents using WOS, From “Meta-cognition” to “Meta-cognitive” from “Metacognition” from “Metacognition” from “Sports” to “Sport” from “Physical Education” from “physical education” from “physical education” to “physical education” Education to conduct a joint search. In order to make the literature searched more comprehensive, the possible synonyms are supplemented.

### 2.2 Inclusion and Exclusion Criteria

In order to ensure that the literature searched can be used in the meta-analysis, this paper relies on the PICOS principle.

Outcomes, Study design to determine the inclusion criteria: (1) The research topic of the literature should be related to metacognition and physical education, and the study subject must be physical education, for example, the influence of metacognition strategies and self-regulation on physical education; (2) The content of the study should include empirical study, which adopts controlled experiment, in which metacognitive intervention is used in the experimental group, traditional teaching methods are used in the control group, and observational experiment is excluded.

### 3 Results of 3-Element Analysis

#### 3.1 Literature Search Results

A total of 773 papers were obtained through basic topic and keyword queries. By checking the original literature, excluding the literature unrelated to PE teaching and metacognition, and deleting the duplicate literature, 169 Chinese literature and 206 English literature were obtained. After screening the inclusion and exclusion conditions, 32 papers were finally obtained and meta-analysis was conducted [13, 26–56]. The sample size of this study ranged from 25 to 601 people from 2004 to 2019, and each article could contain more than one outcome variable. The detailed process of article exclusion, screening, and inclusion is shown in Fig. 1.

#### 3.2 Basic Features and Document Coding

The results of literature coding are shown in Table 1. In order to ensure the accuracy of the coding, two researchers independently coded the features of the literature included in the meta-analysis in this study. In case of disagreement, the two researchers discussed and negotiated together to make modifications.

#### 3.3 Quality Methodological Assessment of the Included Literature

In this study, the included literature subject conditions are clear, the subjects can complete the experiment according to the experimental protocol, their measurement reports are relatively complete, and the baseline of the main outcome indicators of the literature is generally consistent. According to these indicators, 2 high-quality literatures and 21 high-quality literatures are finally included. There were 9 literatures of average quality

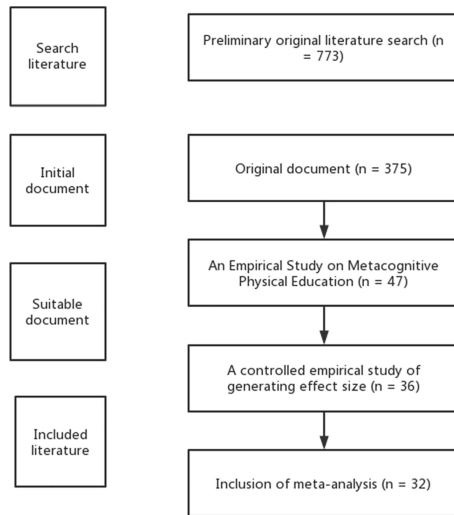


Fig. 1. Flow chart of literature screening. Note: n represents the number of documents.

**Table 1.** Literature coding

research	Sample size	Learning section	Learning project	Intervention strategy	Result variable
Ronnielidor, 2004	28	ES	BA	MS	STR
Marios Goudas, 2017	44	ES	BA	AL	STR&ML
Ahanasia et al., 2018	43	ES	BA&FT&VB &TN	MS	ML&MS
Athanasions et al., 2012	279	ES	FT	SCL	ML&MS
Athanasia et al., 2015	601	JH	Ronnielidor, 2004	SCL	ML&MS
Wei Wang, 2012	25	JH	GN	MS	STR&MS

Notes: ES- Primary School, JH- Junior High School, HS- Senior High School, CS- College, BA- Basketball, FT- Football, TN- Tennis, VB- Volleyball, SP- Shot Put, TT-Table Tennis, Tkd-taekwondo, TC- Tai Chi, MA- Martial Arts, GN- Gymnastics, AT- Track and Field, SS- Speed Skating, MS- Metacognitive Strategies, SML- Self-monitoring Learning, SEL – Self-evaluation learning, SRL – Self-regulating learning, SCL – self-checking learning, AI-autonomous learning, CL – Cooperative Learning, RT – Reflective Teaching, STR- skill test score, ML- metacognitive ability.

(no low-quality literatures). The results of the evaluation of file quality are listed in Table 2.

### 3.4 Heterogeneity Test

Heterogeneity test was conducted on 130 effect sizes included in the meta-analysis. It was found that  $P < 0.00001$  in the Q test was significant heterogeneity, and  $I^2 = 87\% > 75\%$ , indicating a high degree of heterogeneity overall. On this basis, we use random influence model to conduct a meta-analysis. On this basis, through different experimental methods, the students' skill test scores, metacognitive ability and metacognitive strategies are compared, and the corresponding conclusions are drawn. The results showed that the differences among the indexes were statistically significant. The values of  $I^2$  were 78, 89, 85, both larger than 75, indicating that in skill test scores, metacognitive ability and metacognitive strategies, the changes caused by the real difference in effect size were about 78%, 89%, 85%, and the degree of heterogeneity was relatively high. Therefore, it was reasonable to adopt the random effects model in this study (Table 3).

In addition, the influence of metacognitive intervention on physical education teaching may be influenced by other potential moderating variables [57], such as learning period, sports items, intervention strategies, etc.

**Table 2.** Literature quality evaluation table

Research and development	1	2	3	4	5	The total
Ronnielidor, 2004	0	1	0	1	0	2
Marios Goudas, 2017	0	1	0	1	0	2
Ahanasia et al., 2018	0	0	0	1	0	1
Athanasions et al., 2012	0	0	0	1	0	1
Athanasia et al., 2015	0	1	0	1	0	2
Wei Wang, 2012	0	0	0	0	1	1

Note: 1: The inclusion conditions of subjects are specified; 2. Subjects were randomly assigned to each group; 3: The distribution mode is hidden; 4: baseline of major prognostic indicators was constant; 5: Blind all subjects; 6: Blind all the therapists performing the treatment; 7: Blind all raters who measure at least one major outcome; 8: Measure at least one major outcome for more than 85% of people; 9: intention-to-treat analysis; 10: Report on intergroup statistical results for at least one major outcome; 11: The study will provide point measurements and variation measurements for at least one major outcome. Table 1 indicates clear description and 0 indicates unclear description.

**Table 3.** Test of effect size heterogeneity (random effects model)

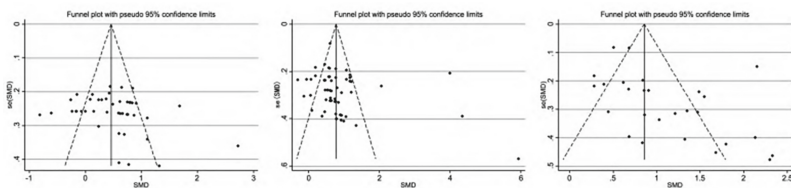
Result variable	Heterogeneity test				
	Tau2	Q	df (Q)	P	I2
Skill test score	0.22	189.89	42	<0.00001	78
metacognition	0.49	540.05	59	<0.00001	89
Meta cognitive strategy	0.27	177.76	26	<0.00001	85

In this study, subgroup analysis (moderated variable effect test) will be conducted in Sect. 3.7 to analyze the influence of moderated variables on the main effect size and reduce possible sources of bias and heterogeneity.

### 3.5 Publication Bias Test

The results show that the effect values of skill test results are uniformly and symmetrically distributed in the middle line, and there are few effect values in the lower left and lower left corner, indicating that the probability of publication bias is very low. The results show that the effect values of metacognitive ability are basically the same, with an axial symmetry, and only a few effect values are located in the left half, so we believe that there is no publication bias. As can be seen from Fig. 2, the effect value of metacognitive strategies is more dispersed and concentrated on the right.

In order to report the publication deviation more accurately, Egger linear regression test was used to detect the publication deviation. Skills test score ( $t = 1.40, P = 0.170$ ),



**Fig. 2.** Publication bias funnel plot (skill test scores, metacognitive ability, metacognitive strategies)

metacognitive ability ( $t = 1.37, P = 0.175$ ), metacognitive strategy ( $t = 2.52, P = 0.018$ ). The T-values of skill test scores and metacognitive ability were both less than 1.96, and the P-values were both greater than 0.05. The data obtained by Egger linear regression test were in line with the standards without publication bias. By comparing the two papers, it was found that there was no publication bias in either paper. Egger regression analysis showed that metacognitive strategies showed different degrees of difference in different degrees, and in different degrees of difference. Through the comprehensive analysis of funnel plot, it is found that this study has a large publishing bias.

## 4 Research Conclusion

(1) In physical education teaching, metacognitive intervention is indeed helpful to improve students' skill test scores, metacognitive ability and metacognitive strategies.  
 (2) metacognitive intervention is regulated by sports items, school period, intervention strategies and other factors to a certain extent.

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