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# Systematic Review and Meta-Analysis of the Effect of the Flipped Teaching Method on Students' Physical Education Learning



**Abstract:** - Flipped teaching method is a new teaching method, which reverses the time inside and outside the classroom, so that students can watch the teacher's video before or after class and learn knowledge independently through the network platform, while the knowledge is internalized and applied through interaction, cooperation, exploration and other ways in the classroom. In recent years, this teaching method has been paid more and more attention and applied in physical education. This paper aims to explore the effect of flipped teaching method on students' physical education learning through systematic review and Meta-analysis. We searched PubMed, web of science, Google Scholar, EBSCO, and Scopus databases for studies on the application of flipped teaching method in physical education from 2018 to 2023. A total of 8 studies that met the inclusion criteria were included. There were 325 students in the experimental group and 319 students in the control group, totaling 644 students. The quality of the study was evaluated according to the evaluation principles of the Cochrane Center for Evidence-based Medicine. RevMan5.4 software was used for Meta-analysis. The results showed that the flipped teaching method had a significant positive effect on the learning effect of students' physical education. Therefore, flipped teaching method can significantly improve the effect of physical education and physical performance, and is worthy of further promotion in physical education.

**Keywords:** Flipped teaching, Physical education curriculum, Learning effect, Meta-analysis.

## I. INTRODUCTION

Physical education is an important part of school education[1], it can not only promote the physical health of students, but also cultivate students' comprehensive quality, such as teamwork, self-confidence, creativity and so on[2]. However, the traditional physical education method often has some problems[3], such as too much control of teachers, low participation of students, low classroom efficiency, and difficulty in meeting individual needs[4]. In order to solve these problems and improve the quality and effectiveness of physical education, Flipped Classroom Method (FCM) has attracted extensive attention and discussion in the education community in recent years [5-14]. Li Dawei (2018) found that flipped classroom is a new teaching method, which effectively solves the problem of space and time limitation in the teaching process and has become another effective method in teaching reform measures. Teachers of various disciplines have used it in classroom teaching and have constantly investigated the application scope of flipped classroom and the problems in the teaching process. Physical education occupies an important position in university teaching and plays an important role in the development of students' physical and mental health. The traditional physical education cannot meet the needs of students, so it should be improved from teaching objectives, methods, evaluation methods and other aspects[15].

Flipped teaching method is a teaching method that inverts the teaching content[16]. It provides traditional teaching content such as knowledge explanation and demonstration operation through video, audio, electronic documents and other multimedia forms for students to learn independently before or after class and moves the traditional after-class homework such as exercises, discussions and projects to the classroom[17]. Guided and assisted by teachers. In this way, students can acquire knowledge according to their own pace and interests before or after class, and they can participate more in high-level learning activities such as practice, communication and cooperation in class, so as to improve the initiative, depth and breadth of learning[18-20]. He Ming (2021) found that excellent video resources in online teaching can be used for pre-class learning in the flipped classroom; The skilled use of all kinds of learning software in online teaching makes the flipped classroom teaching easier to carry out; The characteristics of instant communication in online teaching can be applied to flipped classroom. The form of cross-time

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organization teaching can be applied to the flipped classroom[21]. Yang Xing (2020) found that the flipped classroom teaching of higher vocational physical education through the cloud class platform conforms to the needs of information development. The traditional teaching method led by teachers can no longer meet the needs of today's teaching, and mobile Internet information technology has become an indispensable teaching tool in the development of method in education. Flipped classroom is a reform of physical education teaching methods. The application of flipped classroom in higher vocational physical education has great significance for innovating physical education teaching methods and improving teaching quality[22].

Flipped teaching method has been widely used and studied in various disciplines, among which physical education is also an important field. Flipped teaching method in physical education refers to providing students with theoretical knowledge, skills, rules and other contents through multimedia forms, and learning independently before or after class, and moving sports practice, games, competitions and other activities to the classroom, guided and assisted by teachers[23-26]. Students can fully master sports knowledge and skills before or after class, while they can be more involved in sports and experiences in the classroom, so as to improve the effect and fun of physical education learning[27-29]. Huang Fangfang (2020) found that flipped classroom, as a product of education reform, has been applied to the physical education classroom in higher vocational colleges. This teaching method combines practical courses with online courses, cultivates students' autonomous learning ability, develops the information teaching skills of physical education teachers, enriches the teaching methods of physical education classroom, and realizes the sustainable development of physical education resources[30]. Ding Wen (2019) believes that the application of flipped classroom in the field of physical education is in line with The Times and is an innovative point in physical education classroom teaching. It enriches and improves the classroom charm in the learning process of physical education, effectively avoids the problems existing in traditional teaching, and shows the main line of students' dominant position, the guidance of teachers, and the classroom efficiency of concise teaching and more practice. At the same time, the application of flipped classroom method can fully mobilize the enthusiasm of students and improve the ability of students to master motor skills. It can improve the physical quality of students and promote the improvement of physical performance. It can inspire and promote students' interest in the acquisition of motor skills and improve the ability of communication and exploration and innovation after class.

What are the advantages and challenges of flipped teaching method for physical education? What are the effects of the flipped teaching method on different sports? These questions are the main research content of this paper. In order to answer these questions, this paper used the methods of systematic review and meta-analysis, and collected, screened, evaluated and integrated the relevant literature, in order to provide strong theoretical and empirical support for the reform and development of physical education[31-38].

## II. METHODS

### A. *Studies sources*

In this paper, systematic review and meta-analysis were used to comprehensively collect, screen, evaluate and integrate the relevant literature. PubMed, Web of Science, Scopus, EBSCO, Google Scholar and five major databases were searched. And through reference tracing, the reference list of the literature that has been included in this paper was searched to find the literature that may meet the inclusion criteria of this paper. The literature search time was from January 2018 to December 2023, and the search language was English. The search terms for the literature were "flipped instruction", "physical education instruction", "learning effects", "physical education" and its synonyms or near synonyms, and their combinations. Boolean search formula was used, AND the combination of search terms was AND) and OR.

### B. *Inclusion criteria*

In strict accordance with the PICOS principle, the retrieved literature was preliminarily screened to determine whether it was included in the analysis scope of this paper. Type of study: Only studies using randomized controlled trials were included in this article. Subjects: Only studies with current students as subjects were included in this paper, and studies with teachers or other personnel as subjects were excluded. Research content: This paper only included studies with the application and effect of flipped teaching method in physical education as the research content, and excluded studies that were irrelevant or unclear to the topic of this paper. Study quality: Only studies with some study qualities were included in this paper, that is, they reported the purpose, methods, results and conclusions of the study, and provided adequate data and statistical analysis, while studies with poor study quality or lack of necessary information were excluded.

C. Exclusion criteria

In this paper, the literature after the initial screening was further excluded according to the criteria in the following aspects to avoid duplicate or invalid literature. Duplicate literature: This article excluded literature that was published repeatedly in different databases or journals, and only the earliest or most complete version was retained. Irrelevant literature: This paper excluded literature that was irrelevant or unclear to the topic of this paper, that is, literature that did not explicitly mention the application and effect of flipped teaching method in physical education in the title, abstract or main text. Invalid literature: This article excluded literature that could not be accessed in full or could not be read in full text, and literature that did not provide sufficient data or statistical analysis. This paper also excluded randomized controlled trials that were not of high quality as well as non-standard randomized controlled trials, and excluded articles that were not pre-test post-test comparisons of athletic performance in reading students and studies.

D. Quality assessment

In this paper, a quality evaluation was performed on the literature finally included in the analysis to assess their credibility and validity. This paper used the Cochrane Collaboration's risk of bias tool to evaluate the experimental research literature. The tool includes the following seven aspects of the evaluation criteria: Random sequence generation: to evaluate whether the study used a random method to assign the experimental group and the control group. Allocation concealment: To evaluate whether the study adopted appropriate methods to conceal the allocation of the experimental and control groups to prevent the occurrence of prior knowledge of the groups. Blinding: To evaluate whether a study was blinded, even though participants, implementors, or assessors were unaware of the allocation of experimental and control groups, to reduce the effect of subjective bias. Incomplete outcome data: Evaluate whether studies report all outcome data and whether missing data are properly handled to avoid selection bias. Selective outcome reporting: Evaluation of whether studies reported all prespecified outcome measures and whether unreported outcome measures were accounted for to avoid the effects of reporting bias. Other bias: Evaluate whether there are other biases that may affect the results, such as baseline imbalance, inconsistent intervention between the experimental group and the control group, and different compliance between the experimental group and the control group. Overall bias: Based on the evaluation of the above aspects, the overall bias level of the study was given and divided into three categories: Low risk, High risk and Unclear.

III. RESULTS

A. Studies screening

In this paper, by searching relevant databases and references, a total of 601 literatures related to the application and effect of flipped teaching method in physical education were obtained. Eighteen repeated studies were screened by endnote software, and 522 studies were excluded after careful reading of titles and study abstracts, and the remaining 61 literatures were excluded in the next step. After reading the full text of these 61 studies, 53 studies were excluded according to the research exclusion criteria, and finally 8 studies were included in the analysis scope of this paper. The flow chart of literature screening is shown in Figure 1.

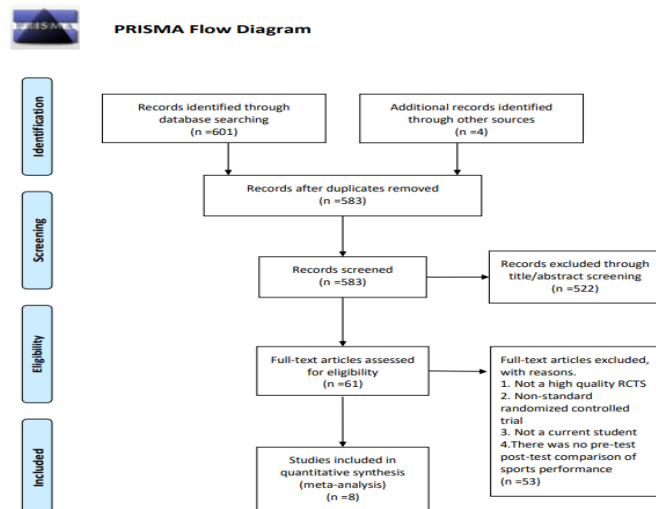


Fig.1 PRISMA flow diagram of study selection

*B. Basic characteristics*

Among the 8 studies included in this paper, all used randomized controlled trials, and the publication time of these studies was from 2018 to 2023, with the largest number of studies in 2023. The basic characteristics of these studies are shown in Table 1.

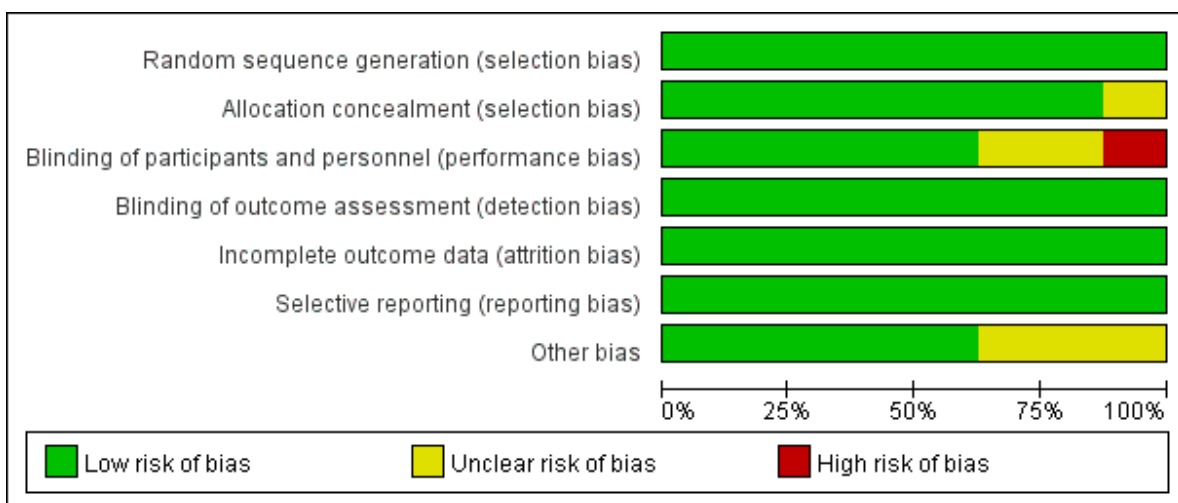
**Table 1.** A list of basic characteristics of the studies included in the meta-analysis

Inclusion study	Country or region	Grade level	Sample size		Teaching project	Intervention duration
			T	C		
Tamer Mahmoud Elsaid Mohamed (2019)	Egypt	University	47	47	Hand ball	None
Bedriye Karaman (2023)	Türkiye	Middle school	32	30	Volleyball	7 weeks
Yen-Nan Lin (2018)	Taiwan.	University	38	38	Dance	9 weeks
Ti Hu (2023)	China	University	34	30	Basketball	16weeks
Nagham Hateem Hameed (2023)	Iraq	University	12	12	hurdlng	8 weeks
Jilian Wang (2023)	The Philippines	Primary school	42	42	calisthenics	12 weeks
Huojin Liu (2019)	China	University	60	60	hurdlng	None
Eman Abdel-Halim Mohamed (2021)	Egypt	University	60	60	volleyball	10weeks

T, experimental group; C, control group

*C. Quality evaluation*

In this paper, the risk of bias tool of Cochrane Collaboration was used to evaluate the quality of the 8 experimental research literatures included, and the results are shown in Figure 2,3. As can be seen from the figure, the quality of these articles is generally high, the risk bias level of most articles is low risk or uncertain, and only a few articles are high risk. Among them, random sequence generation, allocation concealment and blinding are the aspects most prone to high risk of bias, which may be due to the particularity of physical education and it is difficult to achieve complete randomization and blinding. Incomplete outcome data, selective outcome reporting and other biases are the most prone to uncertainty bias, which may be due to the incomplete or clear reporting of the literature, resulting in the inability to judge its bias level. The detailed results are presented in Figures 2 and 3.



**Fig.2** Risk of bias graph of included studies

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Bedriye Karaman2023	+	+	+	+	+	+	?
Eman Abdel-Halim Mohamed2021	+	+	?	+	+	+	+
Huajjin Liu2019	+	+	+	+	+	+	?
Jiliang Wang2023	+	+	?	+	+	+	+
Nagham Hateem Hameed2023	+	?	+	+	+	+	+
Tamer Mahmoud Elsaid Mohamed2019	+	+	+	+	+	+	+
Ti Hu2023	+	+	+	+	+	+	?
Yen-Nan Lin2018	+	+	+	+	+	+	+

Fig.3 Summary of the risk of bias of included studies.

D. Analysis of publication bias

The Funnel plot method was used to analyze the Publication bias of the included 8 studies to detect whether there was Publication bias, that is, the impact of unpublished or unretrieved negative or invalid research results on the analysis results of this paper. The funnel plot is a kind of scatter plot that uses the inverse of the Effect size and its Standard error (precision) of each article as the horizontal and vertical coordinates. If there is no publication bias, the funnel plot should show a symmetrical inverted triangle, that is, there are fewer articles with large effect sizes and the distribution is more concentrated. However, there were more articles with smaller effect sizes and the distribution was scattered. If there is publication bias, then the funnel plot will take on an asymmetric shape, that is, articles on one side are missing or sparse, indicating that these articles may not have been published or retrieved because the effect size is too small or not significant. As can be seen from the figure, most of the funnel plots show a relatively symmetrical shape, indicating that there is no significant publication bias. The funnel plot of publication bias is shown in Figure 4.

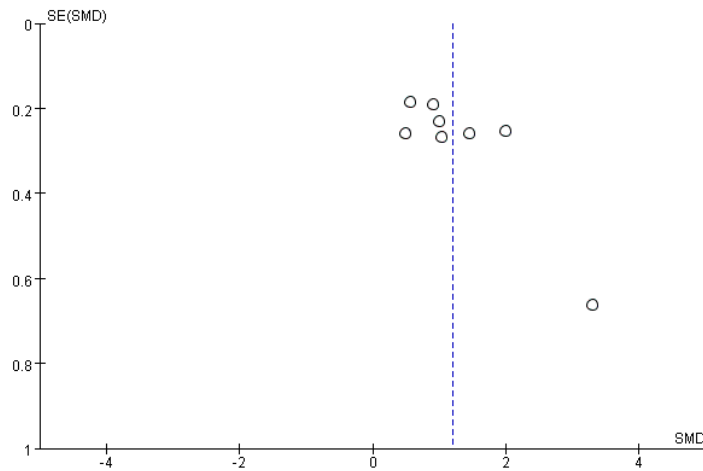


Fig.4 Inverted funnel plot of publication bias

E. Meta-analysis

In this paper, the method of Meta-analysis was used to conduct statistical analysis of the included 8 literatures to comprehensively evaluate the influence of flipped teaching method on physical education learning effect. Meta-analysis is a statistical analysis method that quantifies and integrates the results of multiple independent studies, which can improve the power and robustness of the analysis, while also detecting Heterogeneity and Method variables between different studies. The Random-effects method was used for the meta-analysis. This method assumes that there is real difference in effect size between different studies, that is, there are other factors besides sampling error that cause the variation in effect size. In this paper, the results of meta-analysis were presented by Forest plot. Forest plot is a graph that plots the effect size of each literature and its Confidence interval and the effect size of integration and its confidence interval on a horizontal line, which can visually compare and show the effect size and direction of different literature and integration results, as well as the width and overlap of confidence intervals. In general, a larger effect size and a narrower confidence interval indicate a more significant effect size and greater precision.

F. Overall effect analysis

In this paper, the overall effect analysis of the eight included literatures was conducted[31-38], that is, the effect sizes of all literatures were directly integrated without considering the differences in outcome indicators of different studies to evaluate the overall impact of the flipped teaching method on the learning effect of physical education. The results are shown in Figure 5. As can be seen from the table, the overall effect size of flipped teaching method on physical education learning effect is 1.19, the confidence interval is [0.78, 1.61],  $P < 0.00001$ , indicating that the flipped teaching method is significantly better than the traditional teaching method in the learning effect of physical education, and the effect size is at a high level. At the same time, the heterogeneity  $I^2 = 82\%$  indicates that there is a high heterogeneity, that is, the effect size varies greatly between different literatures and may be affected by other factors. Therefore, sensitivity tests were further performed in this paper to explore the sources and effects of heterogeneity. The forest diagram of the meta-analysis results is shown in Figure 5.

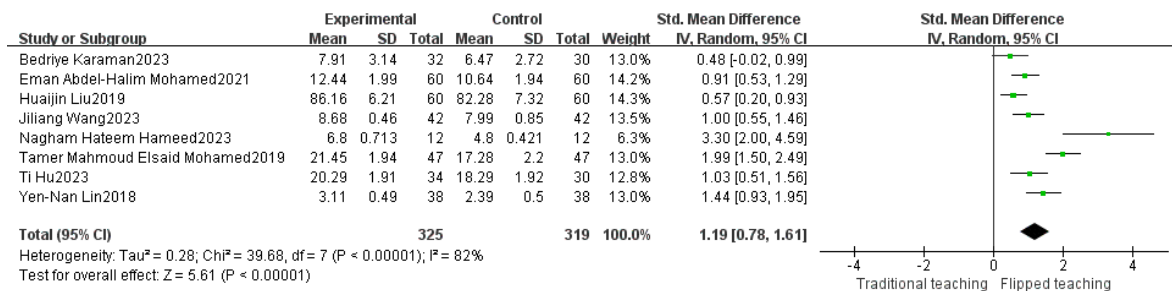


Fig.5 Meta-analysis of the effect of flipped teaching method on students' physical education learning.

G. Sensitivity analysis

In this paper, the sensitivity analysis method was used to analyze the 8 included literatures to detect whether there were individual literatures that had excessive influence on the integration results, that is, Outlier. The method of sensitivity analysis is to delete each reference one by one, recalculate the effect size and heterogeneity of the integration, and then compare it with the original integration result. If the integration result changes significantly after deleting a reference, it indicates that the reference is an outlier and should be excluded from the analysis. The sensitivity test was carried out by the elimination method, and the results showed that the overall effect was stable.

IV. DISCUSSION

This study further integrated the research on the influence of flipped teaching on different sports, retrieved five major databases, and verified the influence of flipped teaching on different sports through systematic review and Meta-analysis. The results showed that flipped teaching method had a significant positive effect on the learning effect of physical education, and the effect size was at a high level. The results show that the application of flipped teaching method in physical education is effective, which can improve students' physical knowledge, skills and attitudes and other aspects of learning outcomes[39-42].

At present, the research on flipped teaching is relatively mature[43-47]. Jiang Liao (2020) found that flipped classroom is a new teaching method that uses Internet technology to give full play to students' subjectivity and autonomy. By studying and combing the nature and characteristics of flipped classroom, combined with experimental research, it is concluded that compared with the traditional physical education teaching method, the flipped classroom teaching can effectively promote the cultivation of students' independent ability, more quickly accept and form motor skills, improve students' interest, and better improve classroom efficiency. Promote teachers to demonstrate, explain and improve the level of Internet operation[48]. Ran Jian (2018) found that the "flipped classroom" teaching method has a positive effect on improving students' learning enthusiasm and autonomy, teamwork ability, and language expression ability. It is suggested to continue to increase the support for the "flipped classroom" teaching reform, optimize the network teaching platform, and improve the teaching means[49]. Zhao Cheng (2021) found that the teaching method of flipped classroom is more and more recognized and respected by the education community, and it is an important symbol of flipped classroom to shift the initiative and decision from teachers to students. In the middle school athletics teaching, the implementation of flipped teaching is a breakthrough to the traditional sports teaching method, which is conducive to changing the roles of students and teachers, stimulating students' enthusiasm for learning, and improving students' sports literacy[50]. These studies also verify the influence of flipped teaching on students' learning of physical education from different angles and provide reference for promoting the reform of physical education[51-55].

The conclusion of this paper provides strong evidence for the application of flipped teaching method in physical education. However, there are also some limitations and deficiencies in this study, which need to be improved and improved in future studies. The small number of included literatures in this paper may affect the universality and representativeness of the study. It is necessary to expand the scope and depth of literature retrieval and increase the proportion and quality of literatures in future studies to improve the credibility and applicability of the study. The method variable analysis in this paper only considered some variables that may affect the effect size, such as research type, research object, sports and research outcome indicators, while ignoring some other possible variables, such as teaching duration, teaching method, teaching evaluation, etc., which may lead to the incompleteness and one-side ability of the study. More method variables need to be further explored and investigated in future studies to reveal more details and mechanisms of the effect of flipped teaching method on physical education learning outcomes.

To sum up, the research of this paper provides a certain theoretical basis and practical guidance for the application of flipped teaching method in physical education, and also puts forward some enlightenment and suggestions for future research, hoping to make some contributions to promoting the reform of physical education and improving the quality of physical education.

## V. CONCLUSION

This paper discusses the influence of flipped teaching method on students' physical education through systematic review and Meta-analysis and obtains the following conclusions: The application of flipped teaching method in physical education is effective, which can significantly improve students' physical education knowledge, skills and attitudes and other aspects of learning outcomes, and the effect size is high. Flipped teaching method has a positive impact on different physical education programs, but for different learning outcome indicators, the degree of influence may be different, which needs to be flexible-adjusted and optimized according to specific teaching objectives and content. The implementation of flipped teaching method needs to consider the influence of a variety of factors, such as teaching hours, teaching methods, teaching evaluation, network platform, teachers' role, students' characteristics, etc., to ensure the quality and effect of teaching. At the same time, attention should be paid to avoid some possible problems and challenges, such as students' learning burden, teachers' workload, network stability, etc.

The research of this paper provides a certain theoretical basis and practical guidance for the application of flipped teaching method in physical education, and also puts forward some enlightenment and suggestions for future research, hoping to make some contributions to promoting the reform of physical education and improving the quality of physical education.

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