REVIEW

The Impact of Stratified Teaching on the Academic Performance of Chinese Middle School Students: A Meta-Analysis

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Abstract*: Stratified teaching is an effective method and means to implement teaching students per their aptitude. Domestic and foreign scholars have carried out many experimental and quasi-experimental studies to observe the impact of stratified teaching on students' academic performance, but the results are quite different. So, can stratified teaching effectively help Chinese students improve their academic performance? How big is its impact? Which model is more suitable for Chinese students? To answer these questions, this article uses meta-analysis to quantitatively analyze 22 Chinese studies on the impact of Stratified teaching on student academic performance. We found that (i) stratified teaching has a positive effect on students' academic performance, and the overall combined effect size is 0.53; (ii) among the seven subjects of mathematics, English, physics, chemistry, biology, geography, and information technology, stratified teaching has had a positive effect on their learning. Stratified teaching's order of effect on different subjects was English > Physics > Geography > Information Technology > Mathematics > Biology > Chemistry; (iii) stratified teaching is suitable for students of different sizes of classrooms. However, the smaller the number of students in the classroom, the better the learning effect, and (iv) stratified teaching is more suitable for improving their learning in the mobile learning system.*

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Problem

"THE teaching by a wise master varies from student to student."[1] Each student has differences in cognitive level, knowledge structure, behavior habits, and emotional attitudes (Xia, 2008). Chinese-style traditional classroom teaching can only meet some students' learning needs, ignore students' differences, and affect students' personality development.

Stratified teaching is a teaching mode formed based on a reflection on the traditional class teaching system. It first recognizes that students are different, so it teaches students in accordance with their aptitude. By changing the traditional teaching organization, updating teaching methods, starting from students' objective differences, and learning that can be achieved, the teaching objects, goals, and activities are hierarchized. Therefore, according to the different levels and types of students, based on their existing knowledge and learning conditions, differently formulate hierarchical learning goals, design hierarchical teaching content, propose different levels of learning needs, and try to make every student get the best development in the level of learning that is most suitable for them (Lu, 2014).

Stratified teaching focuses on improving students' overall quality and pays attention to each student's individual development. It is a classroom teaching mode that solves the contradiction between uniform teaching requirements and individual differences in students' actual learning ability. Stratified teaching is generally recognized abroad and is actively used in daily teaching. Professor Susan Hallam (2002) believes that stratified teaching is to adapt school education to students' differences by constructing diversified courses and teaching, which fully reflects students' subjectivity. The British Ministry of Education believes that Stratified teaching is a kind of "student-centered teaching to meet all students, especially those with special needs" (Wu, 2016). In "*Vision 2020: Report of the Teaching and Learning in 2020 Review Group*" of the UK, stratified teaching was defined as a highly organized and interactive teaching method, which pays more attention to the individual development of students and helps each student tap their potential, and obtain learning achievements in order to actively integrate into the society and move towards success in the future (GTCE, 2020).

Stratified teaching in China is currently in the development and experimental stage. However, due to the large population base in China, the number and proportion of teachers are relatively small compared to the excessive number of students. This has led to many difficulties in the research and implementation of stratified teaching (Hua, 2015). In the pursuit of educational fairness and educational balance, China does not allow large-scale actual stratified teaching, but only small-scale experiments.

Therefore, this article integrates existing Chinese research on the impact of stratified teaching on student learning through literature analysis and uses meta-analysis methods to explore whether stratified teaching is generally applicable to Chinese students and positively impacts their academic performance.

The Background and Significance of Stratified Teaching

Definition and Types of Stratified Teaching

Stratified teaching is a teaching strategy, a teaching model, and a teaching ideology. It focuses on (i) the current level of knowledge and ability of students; (ii) stratification; (iii) all students have been improved. Combining various viewpoints, stratified teaching means teachers divide students scientifically into groups of similar levels based on their current knowledge, abilities, and potential, and then teaches them accordingly. These groups are best developed and improved in teachers' appropriate stratification strategies and interactions (Liu, 2006).

At present, there are generally three types of stratified teaching: "hierarchical grouped fix-class teaching system," "hierarchical shift-class teaching system," and "in-class hierarchical teaching system." "Hierarchical grouped fix-class teaching system" refers to students' basic knowledge and ability level, divided into several levels to form a new teaching class. "Hierarchical shift-class teaching system" refers to the fact that all students in the same grade are divided into several levels based on keeping the original classroom unchanged and teaching in separate classes only for a particular subject. The "in-class hierarchical teaching system" divides students into several levels within the existing natural classes, and teaches at different levels, so that students at all levels can be fully developed (Sun, 2009).

In recent years, in order to avoid the negative impact of stratified teaching on students, "in-class hierarchical teaching" is divided into "in-class dominant stratification" and "in-class recessive stratification." "Dominant stratification" means that students know the stratification of themselves and others, and "recessive stratification" means that only the teacher knows or the teacher and the individual student (parent of the student) know the stratification.

Stratified teaching is a concentrated expression of the "people-oriented" teaching philosophy. It is a concrete implementation of teaching students in accordance with their aptitude in teaching practice and is a teaching model that conforms to the new curriculum reform and meets the needs of students' individual development.

Research Background of Stratified Teaching

Stratified teaching first appeared in the United States. At the beginning of the 20th century, the US taught immigrant children from different countries into groups according to academic performance, ability, and different nationality factors. With the promotion of compulsory education, Stratified teaching has been gradually adopted in Western countries such as the US, Germany, and the UK. In the 1950s, almost all elementary and middle schools in the UK divided students into different levels according to their abilities and allowed students of different levels to learn the same courses in the same class (Boaler, 2000). In the mid-to-late 20th century, along with the introduction and influ-

ence of the "Optimization of Teaching" theory and the Theory of Mastery Learning, many countries started to practice stratified teaching, and some stratified teaching theories and models with international influence emerged, Bloom's Mastery Learning, Keller's personalized teaching system, and Rogers' non-directed teaching still affect the world's teaching field (Peng, 2019).

As early as more than 2,000 years ago in China, the educator Confucius put forward the educational principle of "teaching students per their aptitude" in his book The Analects of Confucius. He mentioned, "To those whose talents are above mediocrity, the highest subjects may be announced. Nevertheless, to those who are below mediocrity, the highest subjects may not be announced." This is the embryonic stage of the thought of stratified teaching. Han Yu, a thinker in the Tang Dynasty, proposed "Teach each person according to his abilities and get the best development," that is, teachers should use different teaching methods according to the students' abilities and qualifications. The Ming Dynasty thinker Wang Shouren put forward the educational principle of "gradually achieve development at different levels according to each individual's abilities." The meaning expressed by it is "people have different levels of acceptance and aptitude; therefore, learning, cultivation, and education should be based on their ability and advance gradually." Wang Fuzhi, a thinker in the Qing Dynasty, advocated that "The students are not uniform, so we have to go in for each person," pointing out that there are individual differences between students, and personalized teaching should be carried out according to the differences between them. These ideas have thoroughly bred the ideas and concepts of stratified teaching (He, 2014).

In the early 20th century, the stratified teaching method was introduced to China. In 1914, Zhishan Zhu's "group teaching method" was the beginning of China's stratified teaching experiment. However, due to the social background and educational situation, stratified teaching did not become the mainstream. It was not until the 1980s that with the introduction of quality education, stratified teaching emerged in China due to the differences between students and education quality requirements. Since the mid-1990s, with the overall development of stratified teaching, all provinces and cities in eastern China and the central and western regions have begun to participate in experimental research on stratified teaching. With the accelerated economic development and the expansion of education scale, stratified teaching has become the mainstream of modern education (Sun, 2009).

Literature Review and Questions

Stratified teaching is one of the "hot spots" and "teaching methods" favored by contemporary Chinese essential education teaching practice. Stratified teaching is mainly displayed in an educational experiment in the reform and practice of fundamental education teaching. For example, the experimental research on "stratified teaching" started in Shanghai in the mid-1980s; the experimental research on "leveled teaching of compulsory courses" carried out by the Affiliated Middle School of Nanjing Normal University in 1992; Model experiment; experimental research on "stratified teaching of junior high

school English" conducted by Zhanggong Middle School in Bengbu, Anhui, etc. Therefore, stratified teaching's experimental research is characteristic of fundamental education teaching reform (Ye, 2003).

The experimental subjects of stratified teaching are mainly concentrated in middle schools and high schools. However, the research on stratified teaching in middle and high schools was carried out in its main subjects. Common subjects used in Stratified teaching experimental research are mathematics, English, physics, chemistry, biology, and geography. Such as Zhang (2005) on the experimental study of stratified teaching in middle school English, Wu (2006) on the implementation of hierarchical research on middle school mathematics, Deng (2012) on the application of "layered and progressive protocol-guided leaning" in high school chemistry teaching, and Zhang (2013) on stratified teaching strategy of high school biology, etc. Stratified teaching in different disciplines has different impacts. For example, Liu (2019) found that under the condition that there is no significant difference in English scores in the pre-test, students' performance in the stratified teaching group was higher than that of the traditional teaching group. The amount was as high as 2.32. However, some studies have found that some disciplines have only a small degree of influence. Zeng (2018) studied on the practice of high school biology stratified teaching showed that in the case of no significant difference in the pre-test, compared with the students in the non-stratified teaching group, the students in the stratified group had only a small improvement, and the effect size was only 0.40.

The experimental research on stratified teaching in China is carried out on a class basis. Traditional Chinese classes generally have around 40-50 students. In some underdeveloped areas, there are 60-80 students in a class due to uneven education. Some schools in the eastern developed areas also carry out small-class teaching, and the average class size is about 20-30 (Zou, 2005). Different class sizes have different effects on stratified teaching. Huang (2013) used a large-class teaching scale in the study of stratified teaching of English reading, and the effect of stratified teaching on student performance was 0.70, while He (2014) chose small-class teaching for stratified teaching of English reading. Its effect size is only 0.28. Therefore, under different class sizes, which are more conducive to improving student performance, is not clear.

Is the length of the experiment period one of the factors that affect the effect of stratified teaching? Literature data show that China's stratified teaching experiment period is roughly divided into three types, such as Tan (2008) and Wei et al. (2014) half-semester teaching experiment research; Zhu (2012) and Gao (2017) one-semester teaching experiment research; Xing (2006), Wang (2011) and Xie (2017) teaching experiment research for one academic year. The effect size of Liu (2015) half-semester study is 0.43, and the effect size of Zhuang (2015) one academic year study is 0.48, the effect size of the two is not much different. Can it be considered that stratified teaching has nothing to do with the length of the experiment period? However, according to Huang's (2011) half-semester research, the experimental result has an effect size of 0.69. Therefore, it can be assumed that stratified teaching is affected by the length of the experimental period.

Domestic experimental research on stratified teaching has mainly focused on shift-class and in-class recessive stratification in recent years. Pu's (2011)'s shift-class stratified teaching, Jin's (2014) in-class stratified teaching, Yan's (2015) in-class group collaboration stratified teaching, and You (2018)'s reactive stratified teaching all show that stratified teaching is useful for students' learning Performance has a positive effect. However, which strategy has a more significant impact on students' academic performance and can promote students' enthusiasm for further research.

In sum, stratified teach has an incredibly beneficial impact on students' academic performance. Stratified teaching is a new teaching model proposed based on respecting individual differences of students. This teaching model follows the theories of "teach students per their aptitude" and "zone of proximal development" to be suitable for students' physical and mental growth and development (Xia, 2010).

However, some scholars question whether stratified teaching is effective? Regarding this issue, countries represented by the United States have conducted extensive investigations and studies. Jeannic Oakes of the University of California has done much empirical research on "Stratified teaching" and found that the effectiveness of "stratified teaching" is questionable, and most studies have shown the ineffectiveness and danger of "stratified teaching" (Sato, 2010). Some scholars in China have also suggested that there are many types of stratified teaching. It is not clear which type of stratified teaching is more suitable? Stratified teaching does not target all disciplines, and some disciplines are insufficient (Chen, 2014). Yu's (2006) research results show no significant difference between the impact of stratified teaching and non-stratified teaching on student performance. Jiang's (2019) research concluded that stratified teaching did not positively affect students' academic performance and decline.

It can be seen that whether stratified teaching positively affects students' academic performance has not been reached a unified conclusion. It is not clear which kind of stratified teaching model helps improve students' academic performance? Is Stratified teaching applicable to all subjects? Scholars have doubts about a series of questions. Although the current research on stratified teaching in China and abroad is abundant, different national systems and national conditions prevent us from directly using foreign research results. Domestic research is often based on theoretical research, and many of the results are suggestions on how to carry out stratified teaching. As for the impact of implementation and its significance, few studies were involved (Xu, 2012). Therefore, compared with traditional teaching methods, it is of great significance to study whether teachers' stratified teaching impacts students' academic performance.

To this end, this article will use meta-analysis to analyze the experimental and quasi-experimental effects of stratified teaching on students' academic performance in China, aiming to answer the following questions:

(i) Compared with traditional classroom teaching, does stratified teaching help students improve their academic performance?

(ii) Does stratified teaching affect students' academic performance in different stages, subjects, class sizes, and experiment cycles, and how much influence does it have?

(iii) Which type of stratified teaching is more conducive to the improvement of students' academic performance?

Methodology

Research Method

Meta-analysis was first proposed by Glass (1976) and applied to clinical psychology. It is a comprehensive and quantitative statistical analysis method for multiple original studies using effect size (ES).

Meta-analysis is widely valued and applied by researchers because it can better control different studies' differences and make them comparable. Compared with traditional narrative reviews, meta-analysis has two outstanding advantages: (i) It can provide comprehensive conclusions relatively scientifically to resolve research disputes and can virtually explore the reasons for differences in different research results. (ii) The existing literature data can be analyzed again, and the research results of a specific field can be discussed without obtaining the original data (Borenstein, 2009).

Meta-analysis does not exclude the evaluator's own research experience, but its conclusions will be more robust and scientific due to stricter norms. Therefore, the meta-analysis method has become an important method to find the "best evidence" in the process of education evidence-based reform (Zeng, 2020).

Research Process

- **Determine Selection Criteria**

Meta-analysis needs to determine the criteria for literature inclusion according to the research objective, content, and statistical requirements. Lipsey (2001) pointed out that the inclusion of literature must include the following essential elements: the salient features of the included literature, research objects, essential variables, research design, cultural and language scope, time frame, and literature type. Based on this, this study formulated the following selection criteria:

(1) The research topic is the impact of stratified teaching on students' academic performance, and stratified teaching is used as the main research variable;
(2) The research must be experimental or quasi-experiment. Based on controlling the difference of the pre-test data, it is necessary to have the pre-test data, and one group of data is stratified teaching;
(3) The research data is complete and should include statistics such as sample size, average, and standard deviation to calculate the effect size;
(4) The research phase is middle school;
(5) The research subjects are basic education subjects, including Chinese, mathematics, English, history, geography, politics, physics, chemistry, biology, etc.;
(6) According to JHU or WWC standards, the experiment period should be 12 weeks or more to ensure its effectiveness;

(7) Students' sample size is based on the class size and is selected according to the class size. In Asia, the number of small classes is generally around 30 (Guo, 2011). Therefore, this time the student sample size is selected to be more than 30 people, and the sample sizes of the two groups are similar to ensure its accuracy;
(8) At least two teachers should teach the experimental group and the control group separately to reduce the influence of teachers;
(9) The focus of this research is the impact of stratified teaching on student performance in the Chinese context. Therefore, the selected studies are all from China. Studies on stratified teaching published before 2000 are mainly qualitative. Therefore, the selected studies are published between 2000 and 2020, and the type of literature is not limited.

- **Literature Retrieval**

Based on the China National Knowledge Infrastructure (CNKI) and Wanfang database, using stratified teaching as the keyword, 43,313 documents were retrieved. Firstly, all the searched literature titles are screened out and imported into Excel for review, and repetitive and non-compliant studies are excluded. Download the documents that may meet the standards and read the abstracts in batches by multiple people to exclude further the research that does not meet the requirements; then, read the document's full text. Finally, search the selected documents again, and finally obtain standard documents that meet the requirements.

According to the selection criteria, 22 studies meet the requirements, and a total of 26 sets of data can be used for analysis (some research samples contain multiple sets of data). The literature search and screening process is shown in **Figure 1**, and the literature screening information is shown in **Table 1**.

- **Characteristic Value Coding**

Different studies contain different characteristic values. In this research, after obtaining the literature on the impact of stratified teaching on students' learning, which can be analyzed, the feature value is coded. The coding objects comprise the author of the literature, the year of publication of the journal, the subject, the learning stage, and the number of samples, the period, and the method. The specific rules are as follows:

(1) Experimental subjects (D): including Mathematics, English, Physics, Chemistry, Biology, Geography, and Information Technology;
(2) Experimental section (Gr): elementary school is pri, middle school is jun, high school is hig;
(3) Experimental number (N): According to the size of the class, the size of the small class is generally between 25-30 (Guo, 2011), coded as S; the traditional class size is generally around 40-50, coded M, a class with more than 50 students is defined as a large class (Hayes, 1997), coded as B;
(4) Experiment period (T): The half-semester experiment period is short, coded as ST, the one-semester experiment period is medium, coded as MT, and the experiment period of one academic year and above is longer, coded as LT;

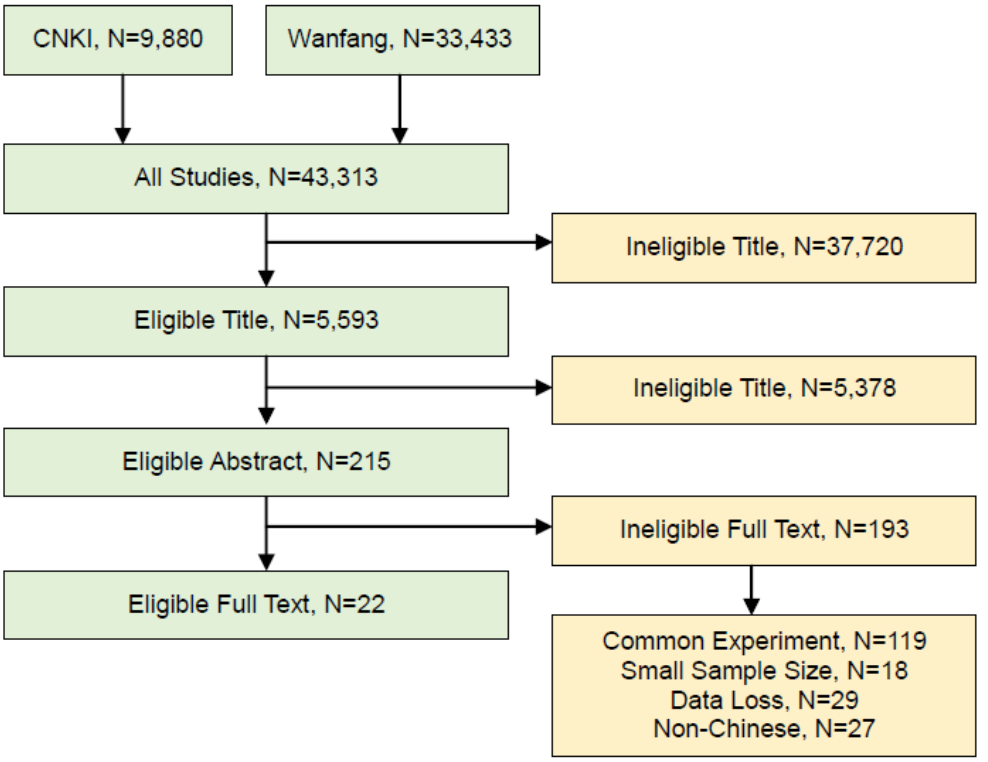

Figure 1. Flow Chart of Literature Search and Screening.

Table 1. Heterogeneity Test Results.

	Effect Size and 95% Confidence Interval					Heterogeneity			
Model	#	Effect Size	SMD	Lower Limit	Upper Limit	Q-value	Df (Q)	P-value	I^2
Fixed	22	26	0.53	0.455	0.598	33.969	25	0.109	26.404
Random	22	26	0.50	0.415	0.590				

(5) Intervention method (M): According to the method of stratified teaching included in the study, in-class dominant hierarchical was coded PO, in-class recessive hierarchical was coded NE, non-dominant and non-recessive in-class stratification was coded GE, the class-shift stratified teaching was coded TR, and the combined dominant and recessive stratified teaching was coded MI.

(6) Research design: i.e., experimental studies or quasi-experiments.

- **Data Analysis**

We used Comprehensive Meta-Analysis 3.0 (CMA3.0) software as a data analysis tool to perform specific analyses on publication bias, heterogeneity test, and effect size.
Results

Study Characteristics

Twenty-two studies based on approximately 3135 junior and senior high school students met the inclusion criteria. The characteristics and findings of these studies appear in Appendix 1. Participants of 12 studies were high school students, and the other 10 were junior high school students. In terms of subjects, over 60% were English and Mathematics, and less than 40% were others. All studies except one (Huang, 2013) were small-scale studies, less than 150 participating students.

In order to examine whether stratified teaching has an impact on students' academic performance and how significant the impact is, this study used meta-analysis software and a random effect model to summarize and analyze the data of stratified teaching (**Table 1**) to show the overall impact of stratified teaching on students' academic performance.

According to **Table 1**, the combined effect size SMD of the included study was 0.53. According to Cohen's statistical theory of effect size, the study produced a moderate effect. It can be seen that stratified teaching has a more significant impact on students' academic performance and can significantly improve it (see details in **Appendix 1**).

The Influence of Stratified Teaching on the Academic Performance of Students in Different Stages

Stratified teaching has an impact on students' academic performance and can improve it. However, for different stages, class sizes, subjects, and whether there are differences in stratified teaching's impact on students' academic performance? In response to this, we did further analysis.

According to the school period, the literature included in this study was divided into middle school and high school. We focused on analyzing the impact of stratified teaching on middle and high school students' academic performance.

According to **Table 2**, the combined effect size of stratified teaching for middle school students is 0.577, and the combined effect size for high school students is 0.47. The effect values are all-around 0.5, which is a moderate effect. The combined effect size test $p = 0.000$ ($p < 0.05$), indicating that stratified teaching positively affects students of different stages. The between-group effect test shows that the difference between the two groups in middle school and high school shows that QBET = 1.176, $p = 0.278$ ($p > 0.05$), indicating that stratified teaching has no significant difference in the academic performance of middle school students and high school students.

Table 2.The Impact of Stratified Teaching on the Learning of Students in Different Stages.

			95% CI		Intergroup Effect Size	
Stage	**#**	**Effect Size**	**Lower Limit**	**Upper Limit**	**QBET**	**P**
Middle School	10	0.58	0.413	0.74	1.176	0.278
High School	16	0.47	0.365	0.574		
Combined Effect Size Test	Z=11.15, P=0.000					

Table 3. The Impact of Stratified Teaching on the Performance of Different Subjects.

			95% CI		Intergroup Effect Size	
Subject	**#**	**Effect Size**	**Lower Limit**	**Upper Limit**	**QBET**	**P**
Biology	3	0.35	0.123	0.567	7.619	0.276
Chemistry	2	0.33	0.067	0.593		
English	8	0.64	0.467	0.821		
Geography	3	0.54	0.287	0.802		
Mathematics	6	0.40	0.241	0.550		
Physics	3	0.55	0.301	0.796		
Information Technology	1	0.45	0.062	0.837		
Combined Effect Size Test	Z=11.17, P=0.000					

Table 4. The Impact of Stratified Teaching on Student Performance of Different Class Sizes.

			95% CI		Intergroup Effect Size	
Class Size	**#**	**Effect Size**	**Lower Limit**	**Upper Limit**	**QBET**	**P**
Big	15	0.44	0.336	0.542	4.727	0.030
Medium	11	0.64	0.491	0.785		
Combined Effect Size Test	Z=11.71, P=0.000					

The Impact of Stratified Teaching on the Performance of Different Subjects

Different disciplines have their characteristics. To investigate whether stratified teaching applies to all disciplines and whether it has different effects on different disciplines, we have discussed the stratified teaching of different disciplines. The subjects included in the study include English, mathematics, physics, chemistry, biology, geography, and information technology. The results are shown in **Table 3**.

According to **Table 3**, all disciplines' combined effect sizes are greater than 0.2, and the combined effect sizes of English, geography, and physics are all greater than 0.5. Judging from the combined effect size test, p = 0.000 indicates that stratified teaching has a moderate impact in different disciplines. From the effect between groups, the difference between groups showed P = 0.276, indicating no significant difference between different disciplines in statistically significant stratified teaching. This shows that disciplines have their characteristics, but stratified teaching positively impacts them. The order of effect size among different disciplines is: English > Physics > Geography > Information Technology > Mathematics > Biology > Chemistry. This shows that stratified teaching positively impacts English, physics, and geography better than chemistry, biology, and mathematics.

The Effect of Stratified Teaching on the Academic Performance of Students from Different Class Sizes

To observe whether stratified teaching has the same effect on students of different class sizes, we divided the number of student samples into small, medium, and large based on the class size of Chinese public schools. Since there are no small-sized classes in the included studies, we chose medium-sized and large-sized classes to analyze the impact of stratified teaching on the performance of students of different class sizes (**Table 4**).

Table 4 shows that the combined effect size of the number of students in large and middle-size classes, Z = 11.712, P = 0.000, indicating that stratified teaching has a significant impact on students' academic performance of different class sizes. From the perspective of the effect size between large and medium-size classes, QBET = 4.727, P = 0.030, reaching a significant level, indicating significant differences in the impact of stratified teaching on the performance of different class sizes. From the perspective of the specific effect size, the student effect size of the large size class is 0.44, the student effect size of the medium size class is 0.64, SMD medium size > SMD large size, indicating that stratified teaching has a more significant impact on the academic performance of students in middle-size classes than students in large-size classes.

The Influence of Stratified Teaching on Students' Academic Performance in Different Experimental Periods

Table 5. The Impact of Stratified Teaching on Student Performance in Different Experimental Periods.

			95% CI		Intergroup Effect Size	
Period	**#**	**Effect Size**	**Lower Limit**	**Upper Limit**	**QBET**	**P**
Long	6	0.50	0.327	0.681	1.944	0.378
Middle	17	0.45	0.351	0.545		
Short	3	0.82	0.280	1.351		
Combined Effect Size Test	Z=10.93, P=0.000					

Table 6. The Impact of In-Class and Shift-Class Stratification on Students' Academic Performance.

			95% CI		Intergroup Effect Size	
Mode	**#**	**Effect Size**	**Lower Limit**	**Upper Limit**	**QBET**	**P**
In-Class Stratification	24	0.51	0.431	0.578	2.098	0.147
Shift-Class Stratification	2	0.99	0.339	1.633		
Combined Effect Size Test	Z=13.77, P=0.000					

Table 7. The Impact of In-Class Dominant, In-Class Recessive and Combined Dominant and Recessive Stratification on Student Academic Performance.

			95% CI		Intergroup Effect Size	
Mode	**#**	**Effect Size**	**Lower Limit**	**Upper Limit**	**QBET**	**P**
Combined Dominant and Recessive Stratification	1	0.65	0.208	1.097	1.685	0.431
In-Class Recessive Stratification	12	0.37	0.255	0.479		
In-Class Dominant Stratification	2	0.45	0.181	0.716		
Combined Effect Size Test	Z=7.67, P=0.000					

Do different experimental periods have different effects on students' academic performance? Is the longer the experiment period, the more significant the impact on students'

academic performance? Therefore, we divide the experimental period included in this study into short, medium, and long periods.

In **Table 5**, the combined effect size Z=10.933, P=0.000 of the effect of long, medium, and short periods on students' academic performance, the effect is significant, indicating that regardless of the length of the experiment period, the stratified teaching improves students' academic performance. Among the group effects, QBET = 1.944, P = 0.378, no significant difference, indicating that no matter how long the experiment period is, it has the same effect on improving student performance. In terms of a single period, the effect size of the short period SMD = 0.82, reaching a significant level; compared to the medium and long periods, the stratified teaching in the short experimental period has the most apparent effect on students' academic performance.

The Impact of Different Stratified Teaching Modes on Students' Academic Performance

We subdivided the stratified teaching model into "in-class dominant stratification," "in-class recessive stratification," "in-class stratification" (not mentioned whether it is dominant or recessive), "shift-class stratification," and "combined stratification of dominant and recessive."

Due to the obscure information of some researches, it cannot be accurately summarized. In order to make the results more rigorous, we subdivide these studies into two small parts and compare them one by one: (i) the impact of in-class stratification and shift-class stratification on students' academic performance (**Table 6**); the influence of "in-class dominant stratification," "in-class recessive stratification," and "combined stratification of dominant and recessive" on student academic performance (**Table 7**).

In **Table 6**, in-class stratification includes "in-class dominant stratification", "in-class recessive stratification", and "combined stratification of dominant and recessive". The combined effect size of in-class stratification and shift-class stratification Z = 13.770, P = 0.000, indicating that no matter which kind of stratified teaching mode, could help students improve their academic performance. The between-group effect size P = 0.147, indicating that different stratified teaching models had no significant difference in the impact of student learning. But in the specific effect size, shift-class stratification (SMD = 0.99) > in-class stratification (SMD = 0.51), indicating that shift-class stratification had a greater impact on students' academic performance.

Table 7 compares the impact of three different stratification modes on students' academic performance in in-class stratification. The results showed that "in-class dominant stratification," "in-class recessive stratification," and "combined stratification of dominant and recessive" all had significant effects on students' academic performance, with the combined effect size Z = 7.666 and P = 0.000. The between-group effect size P = 0.431, indicating that the three in-class stratified teaching models had the same effect on students' academic performance. Among the single effect sizes, combined stratification of dominant and recessive had the best effect on students' academic performance.

Publication Bias Test

Publication bias refers to a phenomenon in which statistical results are positively significant and more straightforward to be accepted and published by journals. When the published research cannot systematically represent the fundamental research completed in the field, it is considered that publication bias has occurred. If there is publication bias, the meta-analysis results may be at risk of amplifying the real effects of interventions (Rothstein, 2006).

Publication bias is an essential factor affecting the reliability of research results, so the test of publication bias is an indispensable part of a meta-analysis. To ensure the scientific characteristics of the stratified teaching results, we used the funnel chart combined with the Egger test to test the publication bias of the included research samples, and the results are shown in **Figure 2**.

In **Figure 2**, the sample effect size of the included study is symmetrically distributed on both sides of the average effect size, indicating that the included study's publication bias is less likely. To avoid the subjectivity of the funnel chart, we combined the Egger method to test further, such as $t < 1.96$, $p > 0.05$, which shows no significant publication bias between studies (Begg, 1994). The results show that $t = 1.53$, $p1 = 0.07$, and $p2 = 0.14$. Based on this, the research on stratified teaching we included is less likely to have publication bias, and the conclusions reached are more reliable.

Heterogeneity Test

Heterogeneity testing is the key to meta-analysis. Due to differences in the sample size, evaluation criteria, and research methods of the initial studies included in the meta-analysis, if there is heterogeneity between the studies, the effect size cannot be combined (Wang, 2018).

According to the statistical principles of meta-analysis, only better homogeneous data can be combined. Therefore, it is necessary to test the heterogeneity of the results of multiple studies to select an appropriate effect model based on the results. When the included studies' heterogeneity is considerable, the random-effects model is generally used for analysis; when the research heterogeneity is small, the fixed effects model will be better (Li, 2018).

Commonly used methods of heterogeneity testing include the Q test and I^2 test. The test level of the Q test is usually set to 0.10. If the heterogeneity test result $p > 0.10$, it can be judged that the studies are homogeneous, and the fixed effects model can be selected. If the heterogeneity test result of multiple studies is $p \leq 0.10$, it can be determined that the studies are not homogeneous, and the random-effects model is used (Borenstein, 2009). The I^2 statistic is a supplement to the Q test's heterogeneity result and can give a more apparent result. The larger the I^2 value, the more significant the heterogeneity. Generally, 25%, 50%, and 75% of I^2 values classify heterogeneity into low, medium, and high grades (Cooper, 1994). When $I^2 = 0\%$, it indicates that there is no heterogeneity between studies; when $I^2 < 25\%$, there is low heterogeneity; when 25%

$\leq I^2 < 50\%$, there is medium heterogeneity; when $I^2 > 50\%$, it is considered that there is high heterogeneity (Higgins, 2003).

Table 1 shows the combined effect values of the 26 groups of student learning data of different stages in 22 stratified teaching studies. The sample heterogeneity test results show that $Q = 33.969$, $p = 0.109$ ($p \leq 0.10$), $I^2 = 26.4\%$ ($25\% \leq I^2 < 50\%$), indicating that the data has medium heterogeneity, so we chose random effect model to remove heterogeneity and combined the data.

Conclusion and Discussion

We analyzed 22 experimental and quasi-experimental studies on the impact of stratified teaching on student academic performance through meta-analysis. It is found that (i) stratified teaching has a moderately positive effect on students' academic performance (effect size is 0.53). (ii) Stratified teaching is more effective when applied to subjects such as English, physics, and geography. (iii) Compared to classes with larger sizes, stratified teaching in middle-size classes is more conducive to improving students' academic performance. (iv) The research effect of stratified teaching with a short experimental period is more significant. (v) Compared with in-class stratified teaching, shift-class stratification is more conducive to improving students' academic performance and the development of physical and mental health.

Stratified Teaching is Significantly Related to Students' Academic Performance

Our study showed that compared with traditional classroom teaching, stratified teaching has a moderately positive impact on students' academic performance (SMD = 0.53). This result was consistent with the results of Shi (2009), Diao (2010), and Ren (2013). We examined the relationship between stratified teaching and student academic performance. According to the results, it can be inferred that the mutual influence mechanism between the above two is that stratified teaching makes it easier for students with similar learning needs to study together and achieve the teaching goals more quickly. Students' sense of accomplishment in problem-solving can be transformed into an individual's internal learning motivation, improve their subjectivity and initiative in learning, and to a certain extent, promote students' awareness of cooperation and competition (Zhang, 2019), thereby helping them essentially improve the academic performance. Xia's (2010) study also mentioned that stratified teaching puts students with similar academic performance and comparable level of ability at the same level, which is in line with students' competitive psychology, strengthens students' sense of competition, can further stimulate students' internal motivation and mobilize students' passion for learning.

The Moderating Effect of Subject, School Stage, Class Size, Experimental Period, and Stratification Modes

The moderating effect test results show that stratified teaching has a positive effect on students' academic performance, but it is restricted by factors such as school stage, subject, class size, experiment period, and stratification mode.

In terms of stages, stratified teaching has similar effects on the performance of middle school students and high school students, and its combined effect sizes were 0.58 and 0.47, respectively, suggesting that it has a moderate impact, that is, stratified teaching has the same effect on middle school students' academic performance.

In terms of subjects, the studies of Jiang (2018), Xiao (2017), and Xia (2010) all showed that stratified teaching had a positive impact on different subjects. However, after analyzing each subject's specific effect size, we found that the effect of stratified teaching on some subjects is more significant, such as English, physics, geography, and mathematics.

In terms of class size, this study shows that compared to large-sized classes, the application of stratified teaching in medium-sized classes is better. Due to the lack of a sample of students from small-size classes in this study, it is impossible to compare stratified teaching's application effects between medium-size and small-size classes. However, small class education has apparent advantages over traditional large-size class education (Huang, 2006). Chen (2020) pointed out that in a large-size class environment, even if teachers have stratified teaching and take into account the mind of each student, they are often limited by their energy. Zhang (2019) emphasized that the class size is large, and the room teacher cannot observe every student in detail, so there is a high probability that students may be stratified to a level that does not match their situation. The implementation of stratified teaching in small-size classes can make teachers' pay more attention to each student's learning situation and promote students' personalized learning. Simultaneously, teaching in small-scale classes can reduce the workload of teachers' class management; so that they can have more time for teaching design to achieve better teaching effects (Wang, 2018).

In the experiment period, we found that students' academic performance is not controlled by the experiment period. Different experimental periods have the same effect on students' academic performance, but from the perspective of a single experimental period, research with a short experimental period can help students improve their academic performance more obviously. However, it can be assumed that this is related to the high degree of teacher input and high student enthusiasm and excitement caused by the short experiment period. The studies of Xu (2005), Wu (2012), and Zhang (2013) showed that stratified teaching would increase the workload of teachers. If the school cannot allocate more teachers, if things go on like this, the teachers' teaching energy will decrease, and the teaching effect will inevitably be significantly reduced. In terms of teaching mode, stratified teaching has multiple teaching modes. In China, the common forms of stratified teaching are "in-class stratification" and "shift-class stratification." "In-class stratification" is divided into "in-class dominant stratification" and "in-class recessive stratification". This study found no significant difference in the impact of different in-class stratification modes on students' academic performance; when teachers are teaching, they can choose dominant stratification, recessive stratifica-

tion, or a combination of the two. Yan (2008), Zhang (2012), and Liu (2015) found that considering the mental health of students, teachers more often choose in-class recessive stratified teaching or group stratified teaching. Compared with in-class stratification, shift-class stratified teaching has a more significant impact on students' academic performance, and its effect size is SMD = 1.009. Shift-class stratified teaching retains the original class, but according to the students' learning level and interest in class at the corresponding level. In this way, students' passive acceptance of knowledge becomes their active absorbing knowledge. This can stimulate students' interest in learning, improve students' academic performance, and promote each student (Lv, 2020). Mou (2020) believed that shift-class stratified teaching ensures the realization of school teaching tasks and meets the diverse development needs of students.

Compared with traditional classroom teaching, stratified teaching is more conducive to students' development, but many factors restrict it. Our research results are based on comprehensive statistical analysis and have absolute reliability. However, because meta-analysis is still an exploratory analysis tool, its conclusions are inferential rather than factorial results and are susceptible to some adjustment variables; therefore, it is necessary to be cautious in promoting results.

Problems and Summary

Our research has found that stratified teaching can meet the learning needs of students at different levels. Stratified teaching can promote the smooth development of classroom teaching and positively impact students' learning attitudes and strategies. However, there are also some problems in the same stratified teaching, which need attention.

Problems

Students want to be recognized by the school, family, and society. In the class, due to the students themselves' individual differences, it will be difficult for some students to change in a short time, lack of learning ability, lowered learning enthusiasm, and eventually lose confidence in learning (Xu, 2012). Stratified teaching follows the principle of "teach students according to their aptitude, proceed in an orderly way and advance step by step," and fully respect the individual differences of students so that they can be more effectively integrated into classroom learning. This is a teaching method that truly considers students and hopes to narrow the differences among students. Nevertheless, in practice, there are often some problems.

- **If Stratified Teaching Is Not Well Controlled, It Will Transform to Diversion**

In most studies, stratified teaching stratification is based on student performance and does not take into account factors such as student abilities, motivation, interests, and cognitive structure. When implementing stratified teaching, teachers should consider these factors; otherwise, the stratification will evolve into a diversion, which is not sig-

nificantly different from the "fast and slow class" teaching in some middle schools (Xu, 2005).

- **Stratified Teaching Tends to Cause Students' Psychological Burden**

After implementing stratified teaching in schools, whether it is recessive stratification, dominant stratification, or shift-class stratification, students are often labeled with A, B, and C levels, which creates psychological problems for middle and low-level students with some kinds of hint. Most studies showed that teachers would communicate and psychologically counsel students at different levels in the early stage of stratification, but the lack of attention in the later stage could easily cause students' psychological imbalance, especially those at the extremes. Therefore, in the entire implementation of stratified teaching, teachers must always give every student care and encouragement to integrate into the new class and maintain the right attitude.

- **Stratified Teaching Lacks Correct Guidance and has not yet Formed a Complete System**

Stratified teaching, which is carried out under the guidance of new educational theories and concepts, requires teachers to get rid of traditional teaching methods and make new attempts, which is problematic. China's current stratified teaching is only used for experimental research and has not formed its own unique, shaped, and realistic method of stratified teaching (Hua, 2015).

Summary

Stratified teaching is a useful exploration of the current situation of Chinese education. Stratified teaching aims to change the original classroom teaching mode and method and design different teaching goals, contents, and tasks according to different teaching objects; so that every student can gain something, feel the joy of learning, and understand the importance of learning. In the end, a set of learning methods suitable for individual students can be formed and can be used in any environment.

Stratified teaching brings advantages to students, increases the intensity and difficulty of teachers' work, and puts forward higher teachers' requirements. Therefore, teachers must advance with the times, strengthen their professional ability, constantly sum up experience, improve teaching models, adjust teaching ideas, and fully mobilize students' learning enthusiasm and initiative to meet students' different needs at different levels.

This study proved that stratified teaching is universally useful and positively impacts students' learning through meta-analysis. However, since this study only focuses on stratified teaching in the Chinese context, and the research stage only focuses on middle and high schools, the overall sample size is small, so the final results need to be treated with caution.

Note

1. *The "The Analects of Four Confucian Classics" by Xi Zhu, an educator in the Song Dynasty of China, means that the saints conduct targeted education based on each person's different qualifications and abilities.*

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Appendix 1.

The 26 Effect Sizes from the 22 Included Studies.

ID	Author(s)	Sample Size	Grade	Period	Subject	Stratification	Design	Effect Size
1	Ren, Z.H. (2013)	T=38 C=38	Middle School	1 Semester	English	In-Class Recessive	Experimental	0.58
2	Liu, T.T. (2015)	T=60 C=60	High School	1/2 Semester	English	In-Class Recessive	Experimental	0.45
3	Qi, G.X. (2012)	T=38 C=38	High School	1 Semester	Physics	In-Class Recessive	Experimental	0.46
4	Huang, W.Q. (2013)	T=352 C=346	High School	2 School Year	English	In-Class	Experimental	0.69
5	He, Y.X. (2014)	T=35 C=35	Middle School	1 School Year	English	In-Class Recessive	Experimental	0.27
6	Gong, Y.X. (2015)	T=58 C=55	High School	1 Semester	English	In-Class Recessive	Experimental	0.52
7	Diao, Y. (2010)	T=52 C=53	Middle School	1 School Year	Technology	In-Class Recessive	Experimental	0.46
8	Sun, X. (2009)	T=41 C=41	Middle School	1 Semester	Mathematics	Combined In-Class Dominant & Recessive	Experimental	0.64
9	Zhang, G. (2004)	T=51 C=50	Middle School	1 School Year	Mathematics	In-Class	Experimental	0.36
10	Guo, M.M. (2011)	T=52 C=52	Middle School	1 Semester	Mathematics	In-Class	Experimental	0.66
11	Zhang, J. (2018)	T=74 C=74	Middle School	1 Semester	Mathematics	In-Class Recessive	Experimental	0.31
12	Xu, M.J. (2014)	T=40 C=40	Middle School	1 Semester	English	Shift-Class	Experimental	0.67
13	Liu, N. (2019)	T=40 C=40	Middle School	1/2 Semester	English	Shift-Class	Experimental	2.39
14	Peng, H.Y. (2019)	T=47 C=45	Middle School	1 Semester	English	In-Class	Experimental	0.85
15	Feng, F. (2014)	T=40 C=40	High School	1 Semester	Geography	In-Class	Experimental	0.35
16	Feng, F. (2014)	T=40 C=40	High School	1 Semester	Geography	In-Class	Experimental	0.60
17	Feng, F. (2014)	T=40 C=40	High School	1 Semester	Geography	In-Class	Experimental	0.48
18	Yan, X.X. (2018)	T=56 C=57	High School	1 Semester	Chemistry	In-Class	Experimental	0.28
19	Yan,J.N. (2005)	T=53 C=55	High School	1 Semester	Biology	In-Class Recessive	Experimental	0.21
20	Yan,J.N. (2005)	T=54 C=52	High School	1 Semester	Biology	In-Class Recessive	Experimental	0.30
21	Yan,J.N. (2005)	T=50 C=52	High School	1 Semester	Biology	In-Class Recessive	Experimental	0.10
22	Zhuang, S.H. (2015)	T=55 C=53	High School	1 School Year	Mathematics	In-Class Dominant	Experimental	0.55
23	Zhang, H.Y. (2012)	T=58 C=58	High School	1 Semester	Mathematics	In-Class Recessive	Experimental	0.10
24	Huang, Y.P. (2011)	T=37 C=36	High School	1/2 Semester	Physics	In-Class	Experimental	0.85
25	Yuan, F. (2008)	T=58 C=54	High School	1 Semester	Physics	In-Class Dominant	Experimental	0.53
26	Xu, J.P. (2005)	T=57 C=55	High School	1 School Year	Chemistry	In-Class Recessive	Experimental	0.58