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A Dynamic Equilibrium Design and Empirical Study of English Tiered Teaching Strategies Combining Multi-subject Games

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Abstract As an innovative teaching mode, tiered teaching can effectively cope with students' individual differences and improve learning effects. In this paper, a dynamic equilibrium model of English layered teaching strategy is designed by combining the multi-subject game theory, which aims to optimize the teaching strategy and improve students' English learning performance through game analysis. The study firstly analyzes the interests and strategy choices among the subjects by establishing a game model involving administrators, teachers and students. Using SPSS data analysis, the study found that tiered teaching had a significant positive effect on student achievement. Students' English scores in the experimental class improved by an average of 15.16 points, while those in the control class improved by only 0.96 points. Further analysis showed that student levels are closely related to teachers' teaching strategies, and the active participation of teachers and administrators can promote the effects of tiered teaching. In addition, the simulation results based on the game model showed that students' academic performance improved more significantly when the initial willingness of administrators and teachers was higher. This study provides specific instructional improvement strategies for educational administrators, especially in the implementation of tiered instruction, emphasizing the active participation of teachers and the policy support of administrators.

Index Terms English tiered teaching, multi-actor game, dynamic equilibrium, teaching strategies, student achievement, game modeling

I. Introduction

In school teaching, tiered teaching is to divide students into different levels of teaching groups according to their learning levels and abilities, and to provide students at different levels with appropriate teaching contents and methods [1], [2]. In English teaching, layered teaching can be categorized according to students' language mastery, listening, reading and writing abilities, so that each student can learn at the level that suits him or her and improve the teaching effect [3]-[5].

The significance of layered teaching is to promote individualized teaching, improve teaching effectiveness, and promote communication and cooperation [6]. Tiered teaching can satisfy students' individual differences and target teaching, so that each student can get the learning content and methods suitable for him/her [7], [8]. In addition, students learn at a level appropriate to their level, which makes it easier for them to understand and assimilate knowledge, improves their learning effect, and enhances their interest and motivation in learning [9], [10]. At the same time, in tiered teaching, students are able to study with their classmates at the same level, communicate with each other and help each other, which promotes communication and cooperation among students and forms a good learning atmosphere [11]-[13]. However, the implementation of layered teaching in English teaching is a long-term, arduous and systematic project, a wide-ranging and demanding work, which requires schools to care about teachers in terms of material, spiritual and welfare benefits, to create a good external environment for the development of teachers in a practical way, to reduce the workload of teachers, so that they can have enough time to study their business, to update their teaching concepts, and to promote their own quality and relevant improvement of business ability [14]-[17].

This study proposes a dynamic equilibrium design of English tiered teaching strategies based on multi-subject game theory, and verifies the effects of different strategy combinations on students' achievement through actual data analysis. By comparing the performance of students in the experimental and control classes, it is found that tiered teaching can effectively improve students' academic performance, especially in the case of students' poor foundation, and tiered teaching can significantly reduce the achievement gap between students. In addition, the

study reveals the important roles of teachers and administrators in tiered teaching, especially the active participation of teachers and the policy support of administrators are important for the improvement of teaching effectiveness.

II. Relevant theoretical foundations

The goal of teaching in the English classroom is to improve students' ability to use English in practice, so the teaching principle should be “practicality as the mainstay, adequacy as the degree, application as the purpose”, highlighting the practicality and relevance of teaching. English classroom teaching is centered on teaching activities, and there is harmony and cooperation, but also disagreement, confrontation and conflict. This seemingly contradictory phenomenon can be regarded as the teacher-student behavior is ostensibly an interactive process of teaching and learning, but in fact it is a game between teachers and students as two independent participants.

II. A. Strategies for Tiered Teaching of English

II. A. 1) Concepts underlying tiered instruction

The so-called hierarchical teaching refers to the advanced teaching method that teachers, on the basis of comprehensively grasping the students' learning potential, existing knowledge level and other important information, divide the students with similar levels into groups, and then implement the differentiated teaching tasks and teaching activities for the students, so as to promote the development of students at all levels [18]. At present, the main points of hierarchical teaching are:

(1) Grasp the current basic level and learning ability of students in the target subjects.

(2) Reasonable division of levels.

(3) All students can be improved based on their own level.

As a whole, the layered teaching mode is mainly divided into two categories, namely, implicit and explicit. The former refers to the internal scale, only the division of students into groups, ignoring the differences between classes, whether the results of stratification or other information is not announced to the students, in general, the main role of the study group and other roles. The latter firmly grasp the individual differences in students to carry out the obvious division of the level, the formation of the level, the teaching process in the teaching content, teaching methods, teaching objectives, teaching evaluation and other aspects of differentiation. When carrying out actual stratified teaching, it is best to implement a combination of invisible stratification and explicit stratification of teaching methods, on the one hand, to make students realize their own shortcomings and form the motivation to strive for, on the other hand, to protect the students' self-esteem and self-confidence in English learning, so that they can complete the learning tasks in a stable psychological state. In turn, they will grow up to be excellent students with cultural character and intercultural awareness, and avoid the polarization of students in the class.

II. A. 2) Value of tiered teaching applications

(1) Teacher level

First of all, the introduction of layered teaching in classroom teaching can bring the relationship between teachers and students closer, breaking the traditional teaching mode in which many teachers only focus on the superior students and poor students in the classroom phenomenon, so that different levels of students can get the attention of the teacher, for the communication between teachers and students to provide a good channel for teachers to better understand the actual situation of students. Secondly, layered teaching can help teachers to improve the effectiveness of classroom teaching, by dividing students into different levels of students, teachers can understand the actual situation of students on the basis of the targeted development of teaching programs, timely adjustment of the classroom teaching rhythm, enhance the efficiency of classroom teaching. Finally, layered teaching is a new type of teaching method, which can effectively enliven the classroom teaching atmosphere, realize the exchange of students at different levels, let students exchange ideas, the collision of thinking, and promote the development of students' comprehensive quality.

(2) Student level

With the introduction of tiered teaching, it can better stimulate students' personal potential, enhance the effectiveness of students' learning programs, and also help students actively participate in classroom teaching activities, timely inform teachers of their own difficulties encountered in the learning process, and master more learning skills. In addition, under the tiered teaching model, students can get help from teachers no matter what their foundation is. The intermediate and lower level students can understand the knowledge better, while the relatively better students can realize the further development of their personal ability on the basis of the original foundation. Therefore, with the help of tiered teaching, students at different levels can make progress implicitly, so as to build up confidence in learning and realize continuous self-development [19].

II. A. 3) Strategies for building tiered instruction

Layered teaching as a teaching mode, in practice, inevitably coexist rational and irrational operational errors, and cause many negative effects. This requires the use of scientific rational principles to strengthen the rational regulation and constraints on irrational operational behavior in teaching practice, in order to reduce or even avoid the emergence of negative effects.

(1) Use the comprehensive requirements of talent cultivation to standardize English layered teaching. Comprehensiveness is the basic requirement of education talent cultivation, and it is also the guiding ideology of teaching that should be adhered to in the first place in layered teaching. In the practice of tiered teaching, teaching managers must first establish a supporting teaching management system to promote the implementation of the principle of comprehensive talent training. Let stratified teaching and talent training of comprehensive constitute a unity, and to comprehensive to standardize the teaching management activities of teachers and teaching managers.

(2) Adhere to the teaching principle of combining subjectivity and dominance. The combination of subjectivity and dominance is the basic principle of English education and teaching. The purpose of implementing hierarchical teaching and taking care of students' differences is to better reflect and give full play to the subjectivity of students' learning, so that students can become the masters of learning, change the negative attitude of "having to learn", and establish the confidence of "I want to learn, I can learn, and I firmly believe that I can learn well". It is only when hierarchical teaching truly reflects the subjectivity of students that the quality of teaching can be improved [20].

II. B.Relevant theories of game theory

II. B. 1) Game theory basics

Game theory can be used to study how game participants make optimal decisions in an uncertain environment. In the game process, at least two or more interactions or mutual influences between game participants will be involved. Gaming is about understanding the interactions between game participants and seeking optimal responses. The general game process consists of three basic elements, i.e., the set of game participants, the set of strategies of all game participants, and the participants' gains and losses or utilities.

(1) Game participants refer to individuals or groups with decision-making rights and interest orientation in the game process, there may be different interests and goals among these participants, but all of them make decisions and influence each other under certain rules.

(2) The set of strategies of game participants. In the process of the game, the game participants can make strategy selection, these strategies can be specific action steps can also be decision-making rules.

(3) The utility function of the game participants. The utility function reflects the decision-making process and the pursuit of interests of the game participants in the game process, describing how the participants make decisions according to the strategies of other participants and their own strategies, so as to obtain the maximum benefit.

Game theory specifically can be formulated as a triad, i.e.:

$$\Gamma = \left\langle N, \{A_i\}_{i \in N}, \{U_i\}_{i \in N} \right\rangle \tag{1}$$

In the game problem Γ, the finite set of participants is denoted $N = \{1, 2, \ldots, n\}$, with a finite number of values N denoting the number of participants in the game and with finite values of n, and the set of strategies available to participant i is denoted by A_i. The utility function of the ith participant is denoted U_i, which is a measure of the benefit of the game participants in the game, and its value depends on the strategies of the participants in addition to the strategies of other participants.

In game theory, it can be categorized based on different types of games, which can usually be divided into two major categories, i.e., cooperative games and non-cooperative games, and the specific classification results are shown in Figure 1. Among them, cooperative game refers to a kind of joint decision-making by each participant in order to maximize the interests of the group, with the purpose of reaching a binding agreement. The non-cooperative game, on the other hand, mainly examines how individual participants can obtain more advantageous benefits and decisions in competition. In addition, games can be categorized in other dimensions such as static vs. dynamic, pure vs. mixed strategies, and complete vs. incomplete information.

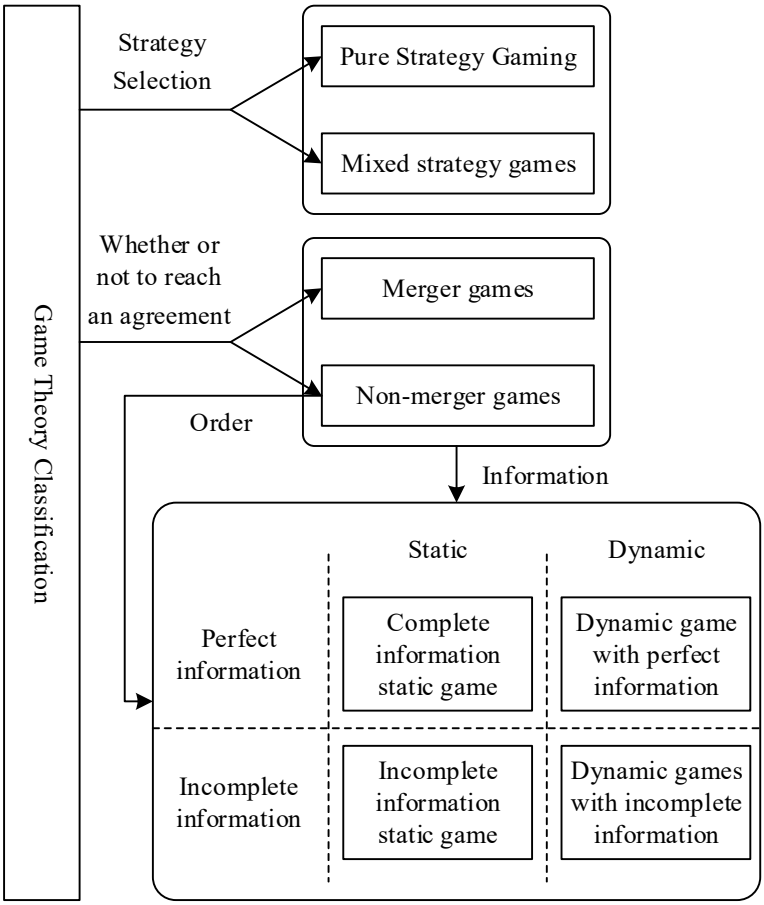


Figure 1: Classification of game theory

II. B. 2) The Steinberg Game

The Steinberg game is a non-cooperative game model in game theory, in which the participants are divided into two roles, the leader and the follower, which are also called the master and the follower, respectively. If u_0 denotes the leader's utility, P denotes the leader's decision, u_m denotes the follower's m utility, and Z_m denotes the follower's m decision. During the game, the leader first makes a decision P, and then the follower m makes his own decision Z_m based on the leader's decision. The leader's goal is to maximize his or her gains by making strategies P^*. To wit:

$$\max_{\mathrm{P}^*} u_0(\mathrm{P}^*, \mathrm{Z}) \tag{2}$$

where Z is the set of follower strategies, and in this non-cooperative game, the leader possesses the ability to be a prophet of the followers' decisions and can choose his own decisions by predicting those of the followers, while the goal of the follower m is to choose the optimal strategy based on the leader's strategy. To wit:

$$\max_{\mathrm{Z}_m^*} u_m(\mathrm{P}, \mathrm{Z}_m^*) \tag{3}$$

The final state of Stackelberg game is Nash equilibrium, for example, in the game between the leader and the follower, when the leader gives a decision, the follower makes a corresponding decision. If both sides can not change the strategy to get more benefits, then both sides of the game have no incentive to modify their own decisions, then at this time will be in Steinberg equilibrium, then both sides of the decision-making is known as the optimal strategy.

Therefore, the Steinberg equilibrium can be described formally:

Given the leader's decision set P and the follower's m strategy set Z_m, if the current game is in a Steinberg equilibrium, there are optimal strategies P^* and Z_m^* that satisfy the following conditions:

$$\forall \mathrm{P}, u_0(\mathrm{P}^*, \mathrm{Z}^*) \geq u_0(\mathrm{P}, \mathrm{Z}^*) \tag{4}$$

$$\forall Z_m, u_m(P^*, Z_m^*) \geq u_m(P^*, Z_m) \quad (5)$$

The Steinberg game is usually solved using backward induction, a method that begins at the final stage of the game, analyzes the possible optimal strategies of the followers, and then gradually infers the optimal strategy of the leader in the previous stage.

III. Dynamic and balanced design of English layered teaching strategies

In recent years, the education sector has carried out reforms in various modes, such as the flipped classroom, the student-guidance system and the walk-in class system. The philosophy of education tells us that human beings cannot exist in isolation from the group, and the same is true for learning. Stratified teaching mode is a kind of learning mode that integrates students of the same level together and generates learning mechanism in communication and collision, which can sublimate the interactivity of teachers and students and students. This chapter establishes a multi-subject game model from the three dimensions of administrators, teachers, and students to explore the dynamic equilibrium design of English layered teaching and to provide support for improving the quality of English teaching.

III. A. Dynamic equilibrium model of multi-subject game

III. A. 1) Multi-subjective interest relationship model

In order to study the issue of interests in English tiered teaching, the study needs to clarify the nature of interests first. Based on the stakeholder theory, the subjects of interest and their claims need to be analyzed emphatically. On the one hand, the partial and holistic nature of interest exists in the situation of dividing the subjects of interest, and on the other hand, the short-term and long-term nature of interest exists in the actual claims of the subjects of interest.

In English tiered teaching, this paper synthesizes the viewpoints of existing studies and limits the subjects of interest analysis to the three categories of students, teachers, and administrators in order to simplify the presentation of the overall and local structure of the interests of English tiered teaching, the specific framework of which is shown in Figure 2. On the students' side, the students' achievement goal claims can be mainly categorized into two types: learning-oriented and achievement-oriented, with the former focusing on the development of their own abilities and the latter on the confirmation of their own abilities. On the teachers' side, tiered teaching gives individual teachers unprecedented communication influence, provides favorable conditions for teachers to assume the social responsibility of knowledge dissemination and realize the professional ambition of teaching, and creates the responsibility and opportunity to lead the teaching practice and its innovation. On the part of administrators, the function of education administrators is to ensure the smooth implementation of education policies and to promote the orderly development of the education sector, and this is where their interests lie.

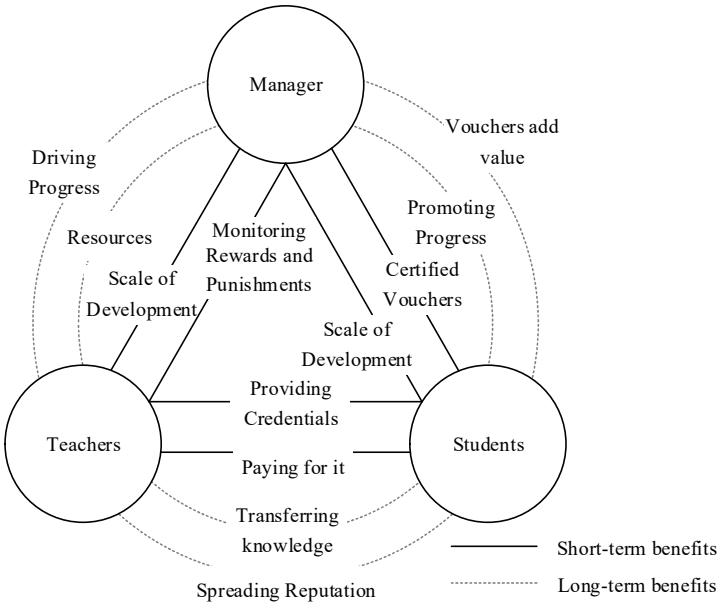


Figure 2: Multi-agent interest relationship model

III. A. 2) Multi-subject game payment matrices

In the "natural" state (if other influences are not taken into account) there exists a system that consists of a finite rational game group representing the behavior of three types of subjects: administrators, teachers, and students, where administrators have two types of choices of strategies, implementation of policy measures for education reform and non-implementation, and teachers have two types of choices of strategies, use of layered teaching and traditional teaching, and students have two types of choices of motivation of interest in learning in the English course, i.e., interested and not interested. There are also two alternative strategies, using tiered teaching and traditional teaching, and there are two types of choices for students' motivation to learn interest in English courses, i.e., interested and uninterested. Administrators, teachers and students of these three types of subjects are difficult to be fully familiar with all the information of the game, under the condition of limited rationality each other is also difficult to study all the results of each other's game, the expected value of the benefits of the three parties of the game can only be predicted with a certain probability.

Table 1 is the payment matrix of the game of multiple subjects, which mainly shows the benefits of administrators, teachers and students in the tiered teaching mode, providing a basis for analyzing the dynamic stabilization strategy of the game of multiple subjects.

Table 1: Multi-agent game payment matrix

Game strategy	Manager benefit	Teacher benefit	Student income
(1,1,1)	$U_1+U_2-u_1$	$T_1+T_2-t_1$	$S_1+S_2-s_1$
(1,1,0)	U_1-u_1	$T_1+T_2+T_3-t_1$	0
(1,0,1)	U_2-u_1	$-y_1-y_2$	S_1-s_1
(1,0,0)	$-u_1$	$T_3-y_1-y_2$	$-z_2$
(0,1,1)	$-u_2$	T_2	S_2-s_1
(0,1,0)	$-x_2-u_2$	T_2+T_3	$-z_1$
(0,0,1)	$-x_1-u_2$	$-y_2$	$S_1-s_1-z_1$
(0,0,0)	$-x_1-x_2-u_2$	T_3	$-z_1-z_2$

III. A. 3) Model stabilization strategy solution

The expected returns to administrators for implementing education reform policy measures and not implementing education reform policy measures are, respectively:

$$\begin{aligned} U_\alpha &= \beta\gamma(U_1+U_2-u_1)+\beta(1-\gamma)(U_1-u_1) \\ &\quad +(1-\beta)\gamma(U_2-u_1)+(1-\beta)(1-\gamma)(-u_1) \\ U_{1-\alpha} &= \beta\gamma(-u_2)+\beta(1-\gamma)(-x_2-u_2) \\ &\quad +(1-\beta)\gamma(-x_1-u_2)+(1-\beta)(1-\gamma)(-x_1-x_2-u_2) \end{aligned} \tag{6}$$

The manager's expected return is:

$$\bar{E}_u=\alpha U_\alpha+(1-\alpha)U_{1-\alpha} \tag{7}$$

Then the replication dynamic equation for the manager's choice of strategy for carrying out policy reforms is:

$$\begin{aligned} F_u(\alpha)=\frac{d\alpha}{dt}&=\alpha(U_\alpha-\bar{E}_u)=\alpha(1-\alpha)(U_\alpha-U_{1-\alpha}) \\ &=\alpha(1-\alpha)\left[\beta(U_1-x_1)+\gamma(U_2-x_2)+x_1+x_2+u_2-u_1\right] \end{aligned} \tag{8}$$

When $\beta=\frac{\gamma(U_2-x_2)+x_1+x_2+u_2-u_1}{x_1-U_1}$, $F_u(\alpha)=\frac{d\alpha}{dt}\equiv 0$, then it means that α can reach a steady state when it takes any value, i.e., administrators can adopt any implementation strategy for teaching.

When $\beta>\frac{\gamma(U_2-x_2)+x_1+x_2+u_2-u_1}{x_1-U_1}$, $\left.\frac{dF_u(\alpha)}{d\alpha}\right|_{\alpha=1}<0$, $\left.\frac{dF_u(\alpha)}{d\alpha}\right|_{\alpha=0}>0$, then $\alpha=1$ is the equilibrium point, suggesting that rigorously carrying out instructional reforms by administrators is an evolutionarily stable strategy.

When $\beta<\frac{\gamma(U_2-x_2)+x_1+x_2+u_2-u_1}{x_1-U_1}$, $\left.\frac{dF_u(\alpha)}{d\alpha}\right|_{\alpha=1}>0$, $\left.\frac{dF_u(\alpha)}{d\alpha}\right|_{\alpha=0}<0$, then $\alpha=0$ is the equilibrium point, suggesting that administrators' leniency in carrying out pedagogical reforms is an evolutionarily stable strategy.

From the replicated dynamic equation of the manager's choice of strategy, when the probability of the strategy that teachers teach carefully to ensure teaching quality is greater than $\frac{\gamma(U_2-x_2)+x_1+x_2+u_2-u_1}{x_1-U_1}$ when α tends to 1, at which point administrators will choose to rigorously carry out instructional reform strategies. Therefore, the greater the probability β that the teacher chooses the strategy of serious teaching to ensure the quality of teaching, the greater the probability that the university chooses to choose the strategy of strictly carrying out teaching reform.

Teachers and students on both sides of the game side of the different strategies of the game payoff and its average payoff is:

$$\begin{aligned} U_{1x} &= y(W_{11}+R-C_1)+(1-y)(W_{21}-C_1)U_{1(1-x)} \\ &= y(H_1-F)+(1-y)(-F) \\ \bar{U}_1 &= xU_{1x}+(1-x)U_{1(1-x)} = (W_{11}+R-W_{21}-H_1)xy \\ &\quad +(W_{21}-C_1+F)x+H_1y-F \end{aligned} \tag{9}$$

Based on the above results, the dynamic equation of replication with the “keep up with the times” strategy is given as:

$$\begin{aligned} F(x) = \frac{dx}{dt} &= x(U_{1x}-\bar{U}_1) = (W_{11}+R-W_{21}-H_1)xy \\ &-(W_{11}+R-W_{21}-H_1)x^2y-(W_{21}-C_1+F)x^2+(W_{21}-C_1+F)x \end{aligned} \tag{10}$$

Similarly, the game payoffs of the different strategies of the game parties and their average payoffs can be calculated as:

$$\begin{aligned} U_{2y} &= x(W_{12}+R-C_2)+(1-x)(W_{22}-C_2)U_{2(1-y)} \\ &= x(H_2-F)+(1-x)(-F) \\ \bar{U}_2 &= yU_{2y}+(1-y)U_{2(1-y)} \\ &= (W_{12}+R-W_{22}-H_2)xy+(W_{22}-C_2+F)y+H_2x-F \end{aligned} \tag{11}$$

Based on the above results, the replication dynamics equation for the “synergistic” strategy is obtained as:

$$\begin{aligned} F(y) = \frac{dy}{dt} &= y(U_{2y}-\bar{U}_2) = (W_{12}+R-W_{22}-H_2)xy \\ &-(W_{12}+R-W_{22}-H_2)xy^2-(W_{22}-C_2+F)y^2+(W_{22}-C_2+F)y \end{aligned} \tag{12}$$

Let $F(x)=F(y)=0$, which can be solved for all replicated dynamic steady states. The game is computed to have multiple equilibria where $x^*=-\frac{W_{22}-C_2+F}{W_{12}+R-W_{22}-H_2}$ and $y^*=-\frac{W_{21}-C_1+F}{W_{11}+R-W_{21}-H_1}$. According to the “stability theorem” of linear equations, the derivatives of $F(x)$ and $F(y)$ (i.e., the slopes of the tangent lines) must be less than 0 at these stable states, and the equilibrium points that satisfy the conditions are the corresponding evolutionary stabilization strategies.

III. B. English tiered teaching design based on multi-subject game

III. B. 1) Selection of Pedagogical Research Subjects

This study takes University T where Province S is located as an example, and a total of 100 students of English Class 1 (50 students) and English Class 2 (50 students) in the College of Foreign Languages in the class of 2021 as the subjects of the study, in which English Class 1 and Class 2 are set up as an experimental class (EEC) and a control class (ECC), respectively. These two classes, as parallel classes of English majors, most of the students have a weak foundation in English, low reading level, low motivation in learning and poor habits, but there are a few students who are active and serious. Aiming at such an academic situation, we study the impact and influence of the layered teaching model in the actual classroom discourse reading teaching, reading class teaching as well as extracurricular reading teaching, and explore the positive influence of the layered teaching model on the students' English performance and the principle of implementation.

III. B. 2) Experimental design for pedagogical research

In order to verify the effectiveness of layered teaching method in English teaching, this study designed a set of detailed layered teaching plan and conducted a semester-long comparative teaching experiment in two classes. In the experimental class, the study used the scores of the opening exam as the basis for stratification, divided the students into L1~L3 levels, and according to the “optimization theory of teaching process” of the existing research, specified the objectives of stratified teaching before the class, carried out the stratified teaching activities during the class, designed the stratified teaching assignments after the class, and conducted the stratified teaching evaluation on the results of the writing. The study also emphasized the importance of the teaching of writing to the students. In the control class, the study followed the traditional English teaching methods, i.e., setting uniform teaching objectives, conducting the same teaching activities, assigning the same homework, and adopting the same evaluation criteria for the whole class. Finally, the students' English learning effect was assessed through the English IV part of the test questions to get the post-test results, and then the SPSS data were analyzed to evaluate the effect of tiered teaching on the students' English performance.

IV. The effectiveness of the application of English layered teaching strategies

In English teaching, teachers should recognize the objective differences between different students, take “individual differences” as the foothold, fully understand the students' learning situation, comprehensively consider and assess the students' basic knowledge, language ability, learning interest, stratify the students, determine different classroom teaching objectives according to the students' actual learning situation, and scientifically develop stratified teaching strategies so as to enhance the effectiveness of classroom teaching. We will determine different classroom teaching objectives according to the actual learning situation of the students, and scientifically formulate the strategy of stratified teaching, so as to enhance the effectiveness of classroom teaching.

IV. A. Simulation of dynamic equilibrium of multi-subject game

IV. A. 1) Impact of students' initial attitudes

Through numerical simulation, it is possible to obtain a more intuitive picture of the evolutionary process and pattern of the English tiered teaching model to promote students' English learning achievement. The initial willingness of administrators and teachers to actively promote the English tiered teaching model as well as each parameter will have an impact on students' English achievement. In order to better show the pattern of influence, the initial values of the parameters are set to meet the conditions of different situations, so as to understand the change of students' initial attitudes towards learning English. The willingness of administrators and teachers to implement the English tiered teaching model is the source of the improvement of students' English performance. If the administrators actively promote the teaching reform, and teachers actively carry out the reform of layered teaching model, and encourage teachers to participate in the implementation through relevant incentives, it may change the results of the three-party game. Figure 3 shows the evolutionary results of the change in students' initial learning attitudes.

When students' initial attitude toward English learning increases from 0.2 to 0.4, and the initial willingness of both administrators and teachers adopts the average value of 0.6, it is found that when students' initial attitudes are low, administrators and teachers will choose the equilibrium strategy of “negative push, traditional push, and negative participation”. When students' initial attitudes are high, administrators and teachers tend to use the evolutionary stabilization strategy of “active promotion, combination of push and pull, and active participation”. When the initial willingness of the main body of the game is low, the evolution of the game can only converge on the traditional equilibrium state of “negative push, traditional push, negative participation”. When the initial willingness of each game subject is high, the evolutionary game tends to the ideal equilibrium state of “positive push, push-pull combination, active participation”. By changing students' initial attitudes towards English learning, the game strategy of the three parties can be optimized, and then improve students' English learning ability. When administrators consider that the English performance of future talents has a low impact on themselves, they do not adopt incentives or respond to the call of national policies, but only maintain the existing mode of talent cultivation. This will result in a vicious circle of students being unable to cope with the actual needs and a mismatch between supply and demand may occur. Improving students' initial attitudes toward English learning will not only affect administrators, but also teachers' strategic choices, which will provide direction for administrators and teachers to develop ways to improve students' motivation to teach English.

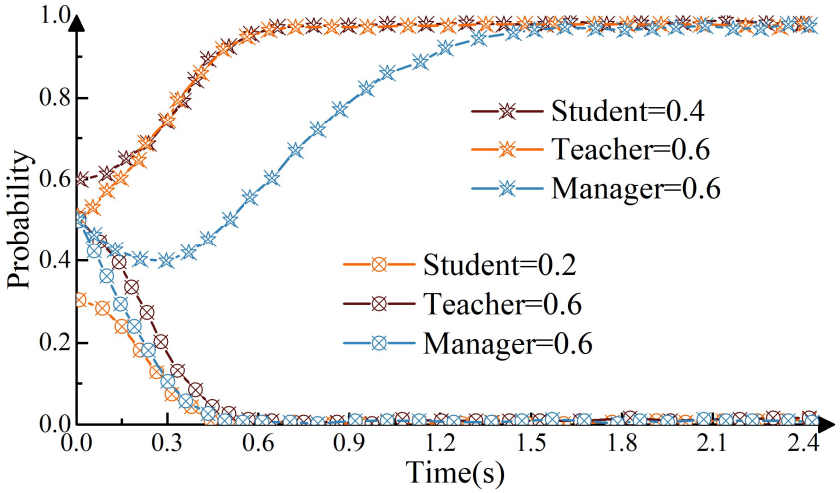
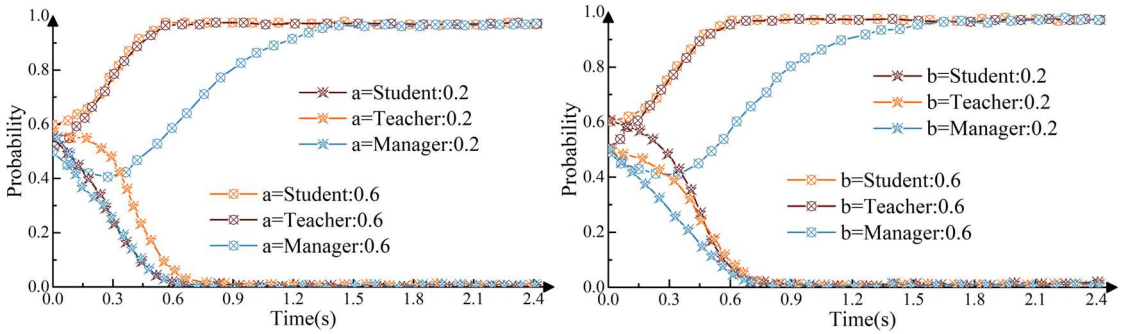


Figure 3: The influence of changes in students' initial attitudes

IV. A. 2) Impact of changes in contribution margins

The improvement of students' English achievement is the result of both administrators' and teachers' efforts. It is specifically quantified as the impact of students' own English achievement improvement and the impact of teachers' implementation of tiered teaching strategies on students' English achievement improvement, which can be simulated by changing the contribution rate coefficient. Figure 4 shows the impact of changes in the contribution rate, where Figures 4(a)~(b) show the changes in the contribution rate of teachers to students and the changes in the contribution rate of students to teachers, respectively.

When the contribution rate of teachers to students' benefits and costs increases (from 0.2 to 0.6), it is equivalent to a decrease in the contribution rate of teachers' contributions to students' benefits and costs. In this case, students, administrators, and teachers will evolve from the equilibrium strategy of "passive push, traditional pushing, and passive participation" to the equilibrium strategy of "active pushing, push-pulling, and passive participation". When the teacher's improvement of students' English performance is less than the manager's organizational factors, that is, the teacher's English performance improvement is greater than the teacher's influence on students' English performance, that is, the role of "pulling" is greater than the role of external "pushing", in this case, the influence of the manager on the improvement of students' English performance is greater than the teacher's own impact on students' English performance. A similar conclusion applies to students. When the contribution rate of students to teachers' benefits and costs increases (from 0.2 to 0.6), which is equivalent to the decrease of teachers' contribution to students' benefits and costs, the impact of students' self-improvement on teachers' ability in practice is often greater than the impact of teachers' ability improvement, the tripartite equilibrium strategy evolves from "passive promotion, traditional pushing, and passive participation" to "active promotion, push-pull combination, and active participation". Therefore, administrators should further strengthen policy reform, and teachers should actively promote the hierarchical teaching model and pay full attention to the cultivation of students' independent ability, so as to meet the current reform needs of students' English performance and English teaching mode.



(a) Teachers to Students (b) Students to Teachers

Figure 4: The impact of changes in contribution rates

IV. B. Validation of English tiered teaching strategies

IV. B. 1) English Learning Achievement Outcomes

Before the practice of tiered teaching, the last final English test scores of the students in the two classes were analyzed and compared using SPSS data analysis software. Table 2 shows the statistical results of the English scores of the students in the two classes before the implementation of tiered teaching.

Before the implementation of the tiered teaching experiment, the number of students in the two classes, the experimental class and the control class, was the same, and the difference between the average English scores of the two classes was also very small, with the mean values of the scores of the experimental class and the control class being 102.15 and 102.63 respectively. The standard deviation of the two classes is close and has a large value, which indicates that the difference in achievement between students within both classes is relatively large. According to the results of the independent samples t-test, we can find that the t-value is 0.375, which corresponds to a two-tailed significance level of 0.758 > 0.05. Therefore, we cannot reject the null hypothesis, which states that there is no significant difference between the means of the experimental class and the control class in terms of their performance on the pre-test English language. This means that the two classes were at similar levels of English proficiency prior to the start of the experiment and can be used as a relatively homogeneous group for subsequent tiered teaching experiments.

Table 2: Pre-test of English proficiency

-	Class	N	Means	STD	St. Err
Pre-test	EEC	50	102.15	12.86	2.514
	ECC	50	102.63	11.95	2.731
Levene's Test for Equality of Variances		T-test for Equality of Means			
		t	Sig.(2-tailed)	95% CI	
F	Sig.			Lower	Upper
0.282	0.634	0.375	0.758	-6.412	9.368

After the implementation of the tiered teaching experiment, the English scores of the students in the two classes were counted again, and their specific statistical results were obtained as shown in Table 3. After the implementation of the tiered teaching experiment, the mean English scores of the students in the experimental class and the control class in the post-test were 118.75 and 103.59 respectively, compared with the pre-test, the mean scores of the two classes have been improved, but the degree of increase in the experimental class is more obvious. In addition, the standard deviation of the mean English scores of the students in the experimental class and the control class were 10.72 and 18.53, respectively, which indicates that the distribution of students' scores in the experimental class has become more centralized, while the control class is relatively decentralized. This may mean that the tiered teaching in the experimental class is more helpful in improving the overall level of students and reducing the achievement differences and differentiation among students. From the results of the independent samples t-test, its two-tailed Sig value is 0.043<0.05, indicating that there is a statistically significant difference, and the average score of the experimental class is 15.16 points higher than that of the control class, and at the same time, it should also be noted that 0 is not included in the upper and lower bounds of the 95% confidence intervals, which suggests that the stratified teaching mode has a certain positive impact on students' English learning, and future research could need to further explore and optimize the experimental conditions to improve its significant impact on students' learning outcomes.

Table 3: Post-test of English proficiency

-	Class	N	Means	STD	St. Err
Post-test	EEC	50	118.75	10.72	2.106
	ECC	50	103.59	18.53	2.895
Levene's Test for Equality of Variances		T-test for Equality of Means			
		t	Sig.(2-tailed)	95% CI	
F	Sig.			Lower	Upper
4.783	0.021	2.897	0.043	0.363	10.527

In addition, this paper divides the experimental class into three levels (L1~L3) according to their English scores, and the paired sample statistics for the pre and post-tests of English scores of the students at different levels, the specific results of which are shown in Table 4. It can be clearly seen that among the students' average scores in the

pre and post-tests, the differences between the average scores of the pre and post-tests of the students at the three levels of L1, L2 and L3 are 0.58, 3.04 and 14.08 points respectively. This indicates that after a semester of study, students at different levels have made some progress, with the greatest progress being made by students at the L3 level. Further observation of the results of the paired samples t-test reveals that L1 level (t=4.129, Sig.=0.013<0.05), L2 level (t=8.763, Sig.=0.008<0.01) and L3 level (t=18.394, Sig.=0,002<0.01). This indicates that the difference between the pre- and post-tests of students' English performance at all levels is significant, especially at the L3 level, which benefits the students the most. This suggests that the tiered teaching model has a positive effect on all students in the experimental class, with students at the L3 level showing the most significant improvement in English achievement. To sum up, tiered teaching has a very positive effect on students' English learning achievement, especially for advanced students, the effect is more obvious, which helps to improve the learning confidence of advanced students and reduce the class polarization gap.

Table 4: The English grades of students at different levels

-	Test	Means	STD	t	Sig.
Pair 1	L1-Pre-test	129.57	4.128	4.129	0.013
	L1-Post-test	130.15	5.106		
Pair 2	L2-Pre-test	110.38	8.517	8.763	0.008
	L2-Post-test	113.42	6.693		
Pair 3	L3-Pre-test	85.76	7.635	18.394	0.002
	L3-Post-test	99.84	5.928		

IV. B. 2) Student Core Literacy Impacts

The analysis of the test results confirms that English tiered teaching has different degrees of influence on students' core literacy, on the basis of which it is necessary to analyze in depth how English tiered teaching affects students' core literacy specifically. For students' English core literacy, this paper mainly quantifies four dimensions: language proficiency, cultural awareness, thinking quality and learning ability. A questionnaire was used in the study to develop a self-assessment scale of students' core literacy, which was quantified using a five-point Likert scale. The questionnaire survey was conducted before the beginning and after the end of the teaching experiment, and the experiment distributed 50 questionnaires and recovered 50 valid questionnaires, with a recovery rate of 100%, and the questionnaire's reliability and validity were in line with the needs, and the results were summarized and analyzed. Table 5 shows the statistical results of students' self-assessment data of core literacy.

The following conclusions are drawn from the comparison of the data of core literacy self-assessment scale before and after the experiment by the students of the three levels:

Overall L3 level students showed the greatest improvement in each core literacy, L2 level students followed, and L1 level students had relatively small changes, mirroring the test results. However, because of the richness and variability of the literacies, the self-assessment results did not show complete consistency. In terms of the changes in students' language proficiency, cultural awareness, quality of thinking, and learning ability literacies, L3 tier students showed the greatest improvement, with values of 26.89%, 34.22%, 27.47%, and 27.27%, respectively. To summarize, after experiencing tiered teaching, each individual's language proficiency, cultural awareness, quality of thinking and learning ability have undergone positive changes, which is very much in line with the researcher's expectation of the study, but the factors of too small a sample size and high randomness cannot be ignored. Among them, cultural awareness and thinking quality improved the most, which suggests that we should pay attention to make up for the lack of education on these two aspects of literacy in our normal teaching, and also suggests that we should pay more attention to the enhancement of students' language proficiency and learning ability in the subsequent tiered teaching, and make better teaching design.

Table 5: The influence of students' core literacy

Level	Core literacy	Pre-test	Post-test	Growth rate
L1	Ability of language	3.05	3.73	7.21%
	Cultural consciousness	2.97	3.51	11.45%
	Thinking quality	3.12	3.62	9.62%
	Learning ability	3.23	3.94	12.69%
L2	Ability of language	3.16	3.75	18.67%
	Cultural consciousness	2.74	3.28	19.71%
	Thinking quality	2.91	3.41	17.18%
	Learning ability	3.08	3.64	18.18%
L3	Ability of language	2.64	3.35	26.89%
	Cultural consciousness	2.25	3.02	34.22%
	Thinking quality	2.73	3.48	27.47%
	Learning ability	2.86	3.64	27.27%

V. Conclusion

As a teaching model for students' differences, tiered teaching can effectively improve students' academic performance, especially in English language teaching with significant effects. Through the experimental study in this paper, it is clear that the positive effect of layered teaching in improving students' English achievement, especially in the weaker student groups, layered teaching can significantly reduce the achievement gap between students. The average achievement of the students in the experimental class increased by 15.16 points, while that of the control class increased by only 0.96 points, indicating that the tiered teaching model is significantly better than the traditional teaching model.

In addition, the results of the study also indicate that the hierarchical division of students plays an important role in the improvement of teaching effectiveness. For students with poor performance, tiered teaching can provide them with more learning support, help them overcome learning difficulties, and improve their self-confidence in learning. Students with better performance can further challenge themselves and improve their abilities through tiered teaching. Therefore, tiered teaching can not only improve students' English performance, but also promote the improvement of students' comprehensive quality.

In conclusion, layered teaching is an effective teaching method that can play an important role in English education. Future research should further explore how to optimize layered teaching strategies to better adapt to students' learning needs and improve overall teaching quality. In addition, the active participation of teachers and administrators, as well as the design of scientific teaching strategies, are crucial to the successful implementation of tiered teaching.

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