Game Evolution Research on the Choice of Training Strategies between Clinical Departments and Doctors under the Background of Hospital-Provided Training

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Abstract: Objective: This study aims to explore the dynamic game process of training participation strategies among hospitals, clinical departments, and newly recruited doctors, as well as the impact of hospital intervention on this process. By applying game evolution theory, a comprehensive model is constructed to analyze the decision-making logic of training participation and propose new training strategies to promote the professional growth of newly recruited doctors and improve hospital service quality. Methods: The stability of dynamic game equilibrium points was analyzed by constructing Jacobian matrices, considering nine different game scenarios with and without hospital intervention. An empirical study from a hospital was introduced to verify the theoretical model's predictions. Results: The study found that without hospital intervention, clinical departments and newly recruited doctors tend to choose not to participate in training. After hospital intervention, through the provision of resources and incentives, the participation and effectiveness of training significantly improved. Conclusion: The study reveals the crucial role of hospital intervention in promoting the participation of newly recruited doctors in training and proposes a training strategy that combines theory and practice. This strategy not only helps new doctors quickly adapt to the hospital environment but also improves the quality of medical services, providing talent support for the hospital's continuous development. It offers theory-based decision support for hospital managers and provides new ideas for the improvement of future medical education and practice.

Keywords: Clinical Medicine; Doctor; Pre-Job Training; Game Evolution; Dynamic Game.

1. Introduction

The National Health Commission of China has proposed a nationwide campaign from 2023 to 2025 aimed at improving patient experience and satisfaction with medical services. This initiative seeks to address urgent issues encountered by the public during medical visits, optimize overall medical service processes, enhance patient experiences, and ensure that the public can enjoy the benefits of high-quality development in public hospitals. Doctor training has become a key link in improving the quality of medical services and patient experiences.

For newly recruited doctors, in particular, a comprehensive and effective training process is not only crucial for their personal career growth but also plays an important role in enhancing the collaboration efficiency of the entire medical team and the quality of hospital services. However, existing research often focuses on traditional education models and skill training, frequently overlooking the social and psychological needs and motivations of individual doctors, as well as the complex interest game between hospitals, departments, and doctors.

In this context, the three-year new employee training program implemented by the author's hospital since 2021 has successfully enhanced the professional quality and comprehensive abilities of newly recruited employees through a systematic and periodic training model. This practice provides us with a valuable real-world case for our research. This study aims to explore a new perspective by introducing social psychology and dynamic game theory into the field of doctor training, with the hope of proposing more precise and effective training strategies.

We hypothesize that by revealing and understanding these deep-level dynamic relationships and psychological mechanisms, we can pave a new path for doctor training, promoting better adaptation and growth of newly recruited doctors while contributing to the high-quality development of hospitals.

2. Literature Review

In recent years, the theoretical background and practical methods of doctor training have become a focus in medical education research. These studies cover various aspects from management theory to adult learning theory and psychological theory. For example, the importance of considering biological, psychological, and sociocultural factors in work training [1], and the motivational characteristics of doctors in continuing medical education and professional development [2].

Training technologies are seen as effective tools for optimizing motivation and goal participation in future medical philosophy doctoral research activities [3], and psychological interventions are particularly important when medical students face medical errors, especially growth mindset theory [4]. The role of adult learning theory in American corporate training [5], an overview of motivation theories in adult education, psychology, and educational psychology over the past 60 years [6], and the influence of intrinsic positive motivation on medical students' cognitive activities and career formation [7] all provide important perspectives for doctor training.

The seven major categories of learning theories in medical education literature [8], as well as theories explaining learning, teaching, and motivation processes in formal and informal educational environments [9], have promoted the development of educational psychology as a diverse discipline. The discussion of self-determination theory on the definition, theory, practice, and future directions of intrinsic and extrinsic motivation [10] also has important guiding significance for doctor training.

A realist review of workplace learning in postgraduate medical education and training [11] aimed to understand how, why, and in what circumstances doctors learn in clinical environments. Research on educational and career motivation issues of graduate students in medical schools [12], and the application of adult education theory in physician assistant education [13], all contribute differently to doctor training. An international study on important transitions in the careers of doctors and other healthcare professionals [14] introduced action theories and theories-in-use regarding teacher learning motivation, barriers, and individual differences [15], as well as research on adult learning motivation [16], providing new perspectives for the application of medical education theory in practice.

Although there have been numerous studies on doctor training both domestically and internationally, most of these studies focus on traditional training models and educational theories, with less involvement in social psychological factors and dynamic game theory in doctor training. Especially in China's medical environment, there is little in-depth analysis of the complex interest relationships and interaction patterns between doctors, hospital managers, and clinical departments. These studies often overlook the needs and motivations of individual doctors at the social psychological level, and how these factors affect the training process and effectiveness.

The innovation of this study lies in introducing social psychology research methods to deeply analyze the dynamic game relationship among hospitals, clinical departments, and newly recruited doctors. This methodological innovation not only broadens the perspective of doctor training research but also provides new ideas for understanding and optimizing doctor training strategies. Through the application of dynamic game theory, this study analyzes in detail the interest demands, behavioral motivations, and possible conflict points of all parties in the training process, thereby proposing more precise and effective training strategies.

3. Game Model

As the de facto funding party, the hospital hopes that newly recruited doctors can quickly familiarize themselves with the environment and reduce medical errors, thereby improving the hospital's reputation and brand. Clinical departments, as specific employers, hope that newly recruited doctors can quickly assume their roles and take on work tasks, reducing the human resource pressure on the department. Newly recruited doctors are eager to establish themselves in clinical departments, obtain economic income, and realize the cost of many years of investment as medical students.

It can be seen that there is a common interest among the three parties, namely, the rapid integration of newly recruited doctors into the hospital environment and familiarity with their work positions, which is beneficial to all three parties. However, the conflict arises from the fact that newly recruited doctors cannot immediately assume their roles. Improving the abilities of newly recruited doctors requires investment in time and economic costs. Relatively speaking, hospitals are more willing to bear these costs, followed by clinical departments, with newly recruited doctors being the least willing to bear them.

In the absence of hospital participation, clinical departments and newly recruited doctors form a community of interests. Due to the lack of constraints and regulation, both clinical departments and newly recruited doctors do not participate in training. When the hospital participates, it bears the economic costs and implements management and incentives for clinical departments and newly recruited doctors, which leads to the breakdown of the community of interests between clinical departments and newly recruited doctors, forming a substantial two-party game.

The strategy choices between clinical departments and doctors show dynamic game characteristics, and the utility of both parties can be measured in monetary terms. Clinical departments and newly recruited doctors are bounded rational. Evolutionary game theory is a kind of repeated game theory, with the research object being groups, based on bounded rationality, seeking Nash equilibrium in reality. In view of this, we will construct the game process of clinical departments and newly recruited doctors participating in training through evolutionary game theory, seeking the interest demands, decision-making processes, and conditions of both parties.

The hospital provides training resources and establishes constraint mechanisms. The two parties participating in the game are clinical departments and newly recruited doctors. The strategy choices for clinical departments are: accept or not accept training, and the strategy choices for newly recruited doctors are: participate or not participate in training. Based on this, the following assumptions are made (all parameters are greater than 0).

Assumption 1: The two parties participating in the game are clinical departments and doctors, and they are bounded rational. The hospital changes the environment of game decision-making by formulating policies. Clinical departments and doctors have strong homogeneity, and the decision-making information and environment of both parties are roughly the same, with generality, and the evolutionary trend of group behavior can be measured through individual behavior.

Assumption 2: Before training, the doctor's performance is P_0, and after training, the performance increases by P_1; P_1 is positively correlated with marginal productivity, and the larger the increase in marginal productivity, the larger P_1.

Assumption 3: In the absence of hospital intervention. When the department does not provide training for doctors, it obtains performance P_0, and the doctor receives a wage W; when the department accepts the hospital's provision of training for doctors, it bears an opportunity cost of Ho, obtains performance P_1 ($P_1 > P_0$), the doctor's wage increases by W_1, and bears an opportunity cost Co. The increased wage W_1 is less than its opportunity cost Co in the short term. Based on Assumption 1, newly recruited doctors choose not to participate in training.

Assumption 4: With hospital intervention. The hospital provides training, and the department chooses to accept or not accept doctors' participation in training. When the department accepts, performance increases by P_1, and it bears the opportunity cost of doctor training Cv; when the department does not accept, the department obtains performance P_0 and bears the hospital's penalty Fd. Doctors participating in training have their wages increased by W_1 and bear an opportunity cost Co; doctors not participating in training receive wage W and accept a penalty Fs.

Assumption 5: The relationship between clinical departments and doctors is relatively stable. If clinical departments do not accept the hospital's training for doctors, doctors generally do not participate in training but will be penalized Fs by the hospital. If clinical departments accept training but doctors do not participate, they face a penalty Fk, where Fk > Fs. Doctors will not resign immediately, so the loss caused to the department by immediate resignation is not considered. This study mainly focuses on the training of doctors with low skill levels within one year of employment, and high-seniority employees are not included.

The representation and meaning of the above parameters are shown in Table 1.

Table 1. Representation and meaning of each parameter

Parameter	Meaning	Relative Relationship
P_0	Performance of newly recruited doctors not participating in training	$P_0 < P_1$
P_1	Performance of newly recruited doctors after participating in training	/
W	Wages obtained by newly recruited doctors after achieving P_0 performance	/
W_1	Increased wages for newly recruited doctors after participating in training	$W_1 < Co$
Ho	Opportunity cost borne by clinical departments for providing training to newly recruited doctors in the absence of hospital intervention	/
Co	Opportunity cost borne by newly recruited doctors for participating in training	/
Cv	Opportunity cost borne by clinical departments for accepting hospital-arranged training for newly recruited doctors with hospital intervention	/
Fd	Penalty amount for clinical departments not accepting hospital-arranged training for newly recruited doctors with hospital intervention	/
Fs	Penalty amount for newly recruited doctors not participating in training when clinical departments do not accept hospital-arranged training with hospital intervention	/
Fk	Penalty amount for newly recruited doctors not participating in training when clinical departments accept hospital-arranged training with hospital intervention	Fk > Fs

3.1. Game Model without Hospital Intervention

Without hospital intervention, the payoff matrix for clinical departments and doctors is shown in Table 2. Generally, the cost Ho for clinical departments to provide training is relatively large, and doctors' performance cannot increase significantly, so $Ho > P_1 - P_0$; newly recruited doctors aim to obtain income directly, and the opportunity cost Co of participating in training is more important than non-monetary benefits A, so Co > A. According to Table 1, using the line method, it can be concluded that in the case of no government participation, the Nash equilibrium of the game is (P_0, W), that is, clinical departments do not provide training, and doctors do not participate in training.

Table 2. Payoff matrix for clinical departments and doctors without hospital intervention

Doctor	Participate	Not Participate
Clinical Department	Train	P_0+P_1-Ho, $W+W_1$-Co
Not Train	P_0, W	P_0, W

3.2. Game Model with Hospital Intervention

The payoff matrix for clinical departments and doctors under hospital intervention is shown in Table 3.

Table 3. Payoff matrix for clinical departments and doctors under hospital intervention

Doctor	Participate	Not Participate
Clinical Department	Accept	P_0+P_1-Cv, $W+W_1$-Co
Not Accept	P_0-Fd, W-Fs	P_0-Fd, W-Fs

Let the probability of doctors participating in training be x ($0 \le x \le 1$), and the probability of not participating be 1-x. Let the probability of clinical departments accepting training be y ($0 \le y \le 1$), and the probability of not accepting be 1-y. The expected returns for doctors are Ue_1 and Ue_2 respectively, and the average expected return is Ue. The expected returns for clinical departments are Ui_1 and Ui_2 respectively, and the average expected return is Ui. According to the fitness function formula, we get:

$Ue_1 = y(W+W_1-Co) + (1-y)(W-Fk)$ (1)

$Ue_2 = y(W-Fs) + (1-y)(W-Fs)$ (2)

$Ue = xUe_1 + (1-x)Ue_2$ (3)

$Ui_1 = x(P_0+P_1-Cv) + (1-x)(P_0-Cv)$ (4)

$Ui_2 = x(P_0-Fd) + (1-x)(P_0-Fd)$ (5)

$Ui = yUi_1 + (1-y)Ui_2$ (6)

Based on these equations, we can derive the strategy proportion replication dynamic equations for clinical departments and doctors:

$F(x) = dx/dt = x(Ue_1-Ue) = x(1-x)[y(W_1-Co+Fk)-Fk]$ (7)

$F(y) = dy/dt = y(Ui_1-Ui) = y(1-y)(xP_1-Cv+Fd)$ (8)

4. Evolutionary Analysis

An evolutionarily stable strategy (ESS) is defined as a strategy which, if adopted by a population in a given environment, cannot be invaded by any alternative strategy that is initially rare. It is a key concept in evolutionary game theory and is an application of Nash equilibrium in biology. For a very small positive number ε, for all dynamic systems $\sigma \neq \sigma^*$, the following condition is satisfied: $u(\sigma^*, (1-\varepsilon)\sigma^*+\varepsilon\sigma) > u(\sigma, (1-\varepsilon)\sigma^*+\varepsilon\sigma)$, which means that when a very small proportion ε of mutant behavior σ appears in the population, adopting strategy σ* will yield higher returns. Therefore, strategy σ* is an evolutionarily stable strategy [15].

Let F(x) = 0, we get $x_1 = 0$, $x_2 = 1$, $y_3 = Fk/(W_1\text{-}Co+Fk)$. Let F(y) = 0, we get $y_1 = 0$, $y_2 = 1$, $x_3 = (Fd\text{-}Cv)/P_1$. When x and y simultaneously satisfy F(x) and F(y) = 0, we obtain five equilibrium points: E1(0,0), E2(0,1), E3(1,0), E4(1,1), E5($(Cv\text{-}Fd)/P_1$, $Fk/(W_1\text{-}Co+Fk)$). The stability of dynamic game equilibrium points can be judged by the local stability of the Jacobian matrix. In discrete dynamic systems, an equilibrium point is stable if and only if the determinant (DET) of the Jacobian matrix is greater than 0 and its trace (Tr) is less than 0. By taking partial derivatives of F(x) and F(y) with respect to x and y, we obtain the Jacobian matrix as follows:

$[[(1\text{-}2x)[y(W_1\text{-}Co+Fk)\text{-}Fk], x(1\text{-}x)(W_1\text{-}Co+Fk)], [y(1\text{-}y)P_1, (1\text{-}2y)(xP_1\text{-}Cv+Fd)]]$

Fd is the penalty for clinical departments not accepting training, Cv - Fd is the net benefit for enterprises not accepting training, although penalized by the hospital, but saving costs, Cv - Fd - P_1 is the difference in benefits between enterprises not accepting training and accepting training. When Cv - Fd > 0 and Cv - Fd - P_1 > 0, then (Cv - Fd)/P_1 > 1; when Cv - Fd > 0 and Cv - Fd - P_1 < 0, then 0 < (Cv - Fd)/P_1 < 1; when Cv - Fd < 0, then (Fd - Cv)/P_1 < 0.

W_1 - Co is the direct benefit for doctors participating in training, equal to the benefit of participating in training W_1 minus the cost of participating in training Co, so its positive or negative is unknown. W_1 - Co + Fk is the net benefit of participating in training, including direct benefits plus avoided penalties Fk, its positive or negative is undetermined. If W_1 - Co + Fk < 0 and < -Fk, then doctors would rather be penalized than participate in training, if W_1 - Co + Fk is much greater than 0, then doctors are willing to participate in training. Since the opportunity cost Co and penalty Fk are known, the doctor's net benefit depends on W_1. When -Fk < W_1 - Co + Fk < 0, it indicates that the net benefit of workers participating in training is negative, but smaller than the penalty for not participating in training; when 0 < W_1 - Co + Fk, the doctor's net benefit is positive; when Fk < W_1 - Co + Fk, its net benefit is positive and very large. When 0 < W_1 - Co + Fk and 0 < W_1 - Co + Fk - Fk, then Fk/(W_1 - Co + Fk) belongs to [0,1]; when 0 < W_1 - Co + Fk and 0 > W_1 - Co + Fk - Fk, Fk/(W_1 - Co + Fk) > 1; when 0 > W_1 - Co + Fk, Fk/(W_1 - Co + Fk) < 0.

Case 1: Cv - Fd > 0, 0 < (Cv - Fd)/P_1 < 1 and Fk < W_1 - Co + Fk, 0 < Fk/(W_1 - Co + Fk) < 1. The system has five equilibrium points: E1, E2, E3, E4, E5. The stability of the Jacobian matrix is shown in Table 4, and the phase diagram is drawn accordingly (Figure 1a). According to the phase diagram, the system converges to E1 and E4. E1 indicates that clinical departments do not provide training because the net benefit of not accepting training is greater than 0, and doctors have no opportunity to participate in training. E4 indicates that clinical departments provide training because the net benefit of not providing training is less than the benefit of providing, and workers participate in training because of the large net benefit of participating.

Case 2: Cv - Fd > 0, 0 < (Cv - Fd)/P_1 < 1 and 0 < W_1 - Co + Fk < Fk, Fk/(W_1 - Co + Fk) > 1. The system has four equilibrium points: E1, E2, E3, E4. Its phase diagram and stability are shown in Figure 1b and Table 5. The system converges to E1, meaning clinical departments do not accept training provided by the hospital, and doctors cannot participate in training.

Table 4. Local stability analysis of equilibrium points

Equilibrium Point	Sign of Jacobian Matrix DET	Sign of Jacobian Trace TR	Result
E1	+	-	Stable
E2	+	+	Unstable
E3	+	+	Unstable
E4	+	-	Stable
E5	-	0	Saddle point

Table 5. Local stability analysis of equilibrium points

Equilibrium Point	Sign of Jacobian Matrix DET	Sign of Jacobian Trace TR	Result
E1	+	-	Stable
E2	-	Uncertain	Saddle point
E3	+	+	Unstable
E4	-	Uncertain	Saddle point

Case 3: Cv - Fd > 0, 0 < (Cv - Fd)/P_1 < 1 and W_1 - Co + Fk < 0, Fk/(W_1 - Co + Fk) < 0. According to the Jacobian matrix determinant and trace (Table 2) and phase diagram 1b, the system has four equilibrium points E1, E2, E3, E4, converging to E1. Clinical departments do not accept training provided by the hospital, and doctors have no opportunity to participate in training.

Case 4: Cv - Fd > 0, (Cv - Fd)/P_1 > 1 and Fk < W_1 - Co + Fk, 0 < Fk/(W_1 - Co + Fk) < 1. The system has four equilibrium points: E1, E2, E3, E4. The stability of the matrix is shown in Table 6, and the phase diagram is shown in Figure 1c. The system converges to E1, clinical departments do not accept training, and doctors have no opportunity to participate in training.

Table 6. Local stability analysis of equilibrium points

Equilibrium Point	Sign of Jacobian Matrix DET	Sign of Jacobian Trace TR	Result
E1	+	-	Stable
E2	+	+	Unstable
E3	-	Uncertain	Saddle point
E4	-	Uncertain	Saddle point

Case 5: Cv - Fd > 0, (Cv - Fd)/P_1 > 1 and 0 < W_1 - Co + Fk < Fk, 1 < Fk/(W_1 - Co + Fk). The system has four equilibrium points E1, E2, E3, E4, converging to E1. The stability of the Jacobian matrix is shown in Table 7, and the phase diagram is shown in Figure 1d.

Case 6: Cv - Fd > 0, (Cv - Fd)/P_1 > 1 and 0 > W_1 - Co + Fk, 0 > Fk/(W_1 - Co + Fk). The system has four equilibrium points E1, E2, E3, E4. Case 6 is the same as Case 5, the stability of the Jacobian matrix is shown in Table 4, and the phase diagram is shown in Figure 1d. The system has one equilibrium point E1, meaning clinical departments do not accept training provided by the hospital, and doctors have no opportunity to participate in training.

Table 7. Local stability analysis of equilibrium points

Equilibrium Point	Sign of Jacobian Matrix DET	Sign of Jacobian Trace TR	Result
E1	+	-	Stable
E2	-	Uncertain	Saddle point
E3	-	Uncertain	Saddle point
E4	+	+	Unstable

Case 7: $Cv - Fd < 0$, $(Cv - Fd)/P_1 < 0$ and $Fk < W_1 - Co + Fk$, $0 < Fk/(W_1 - Co + Fk) < 1$. The system has four equilibrium points E1, E2, E3, E4, the stability of the matrix is shown in Table 8. The phase diagram 1e shows that the system converges to E4, clinical departments accept training because the benefit of accepting training is greater than not accepting, and doctors participate in training because of the large benefit of participating.

Table 8. Local stability analysis of equilibrium points

Equilibrium Point	Sign of Jacobian Matrix DET	Sign of Jacobian Trace TR	Result
E1	-	Uncertain	Saddle point
E2	-	Uncertain	Saddle point
E3	+	+	Unstable
E4	+	-	Stable

Case 8: $Cv - Fd < 0$, $(Cv - Fd)/P_1 < 0$ and $0 < W_1 - Co + Fk < Fk$, $1 < Fk/(W_1 - Co + Fk)$. According to the matrix stability analysis (Table 9), the system has four equilibrium points E1, E2, E3, E4, the system converges to E2 (phase diagram 1f) indicating that clinical departments' benefit of not accepting training is less than accepting training, but doctors have low willingness to participate in training due to small benefits from participation.

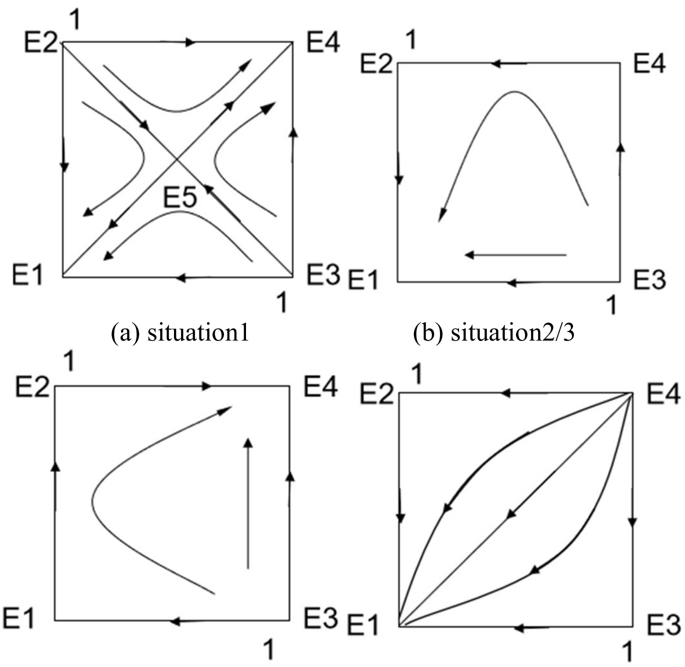
Table 9. Local stability analysis of equilibrium points

Equilibrium Point	Sign of Jacobian Matrix DET	Sign of Jacobian Trace TR	Result
E1	-	Uncertain	Saddle point
E2	+	-	Stable
E3	-	Uncertain	Saddle point
E4	-	Uncertain	Saddle point

Case 9: $Cv - Fd < 0$, $(Cv - Fd)/P_1 < 0$ and $W_1 - Co + Fk < 0$, $Fk/(W_1 - Co + Fk) < 0$. The system has four equilibrium points E1, E2, E3, E4, the stability of the Jacobian matrix (Table 9) and phase diagram (Figure 1f), the system converges to E2. Cases 8 and 9 are the same.

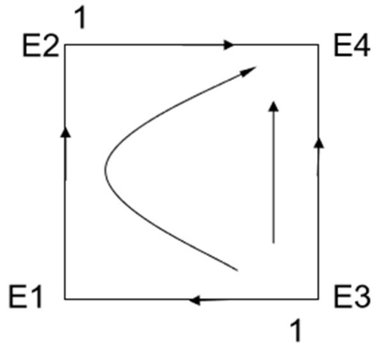
In summary, in the 9 cases, E1, E2, E4 are stable equilibrium points of the system. Cases 1-6 converge to E1, clinical departments do not accept training provided by the hospital because the benefits are less than the costs, and at the same time, doctors have no opportunity to participate in training. Cases 1 and 7 converge to E4, indicating that when clinical departments obtain benefits greater than costs and doctors obtain relatively large benefits, both clinical departments and doctors are willing to conduct training. Cases 8 and 9 converge to E2, at this time, doctors are willing to participate in training because the benefits obtained are greater than the costs, but clinical departments' benefits are less than the costs, so they are unwilling to accept training provided by the hospital.

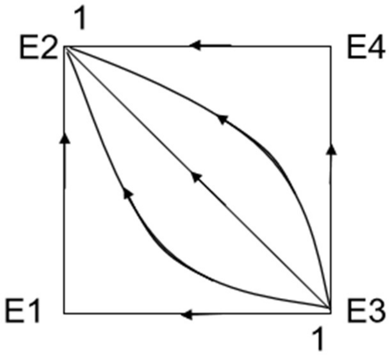
Figure 1 shows that the broken line connected by E2, E3, and E5 forms the critical line of different convergence regions. The upper right part of the broken line converges to E4, and the lower left part converges to E1. Therefore, convergence to E1 or E4 is related to the initial state and is affected by the movement of E5.



(a) situation1 (b) situation2/3

(c) situation3 (d) situation5/6





(e) situation6 (f) situation8/9

Figure 1. phase diagram

5. Discussion

Although most hospitals concentrate the training of newly recruited doctors within about a week before they enter clinical work, the author's hospital has demonstrated through three years of practice that continuous training and reinforcement are crucial for the growth of newly recruited doctors. Our research, by constructing a dynamic game model, deeply explores the impact of hospital intervention on the training participation strategies of clinical departments and newly recruited doctors. The model predicts that without hospital intervention, clinical departments and newly recruited doctors tend to choose not to participate in training, which echoes the adult learning theory proposed by Schenck [1]. However, when hospitals intervene and provide incentive measures, our model predicts a new equilibrium state where clinical departments and newly recruited doctors are more likely to choose to participate in training, which is consistent with the research of Iobst et al. [2], emphasizing the importance of motivational characteristics in doctors' continuing education.

This study supports this theoretical prediction. Through providing resources, incentive measures, and continuous assessment, hospitals have successfully promoted the training participation of newly recruited doctors. The post-training competency, communication skills, and understanding and identification with hospital culture of new employees have all significantly improved. Data shows that new employees' self-assessment scores in team cooperation (85% score) and communication skills (90% score) are generally high, and department members' overall evaluation of new employees has also increased to 92%. These results not only confirm the effectiveness of the game model but also provide valuable experience for other medical institutions.

Furthermore, our research further supports Oliinyk's view [3] that training technology can be an effective tool for optimizing the learning process. In the context of hospital intervention, training not only provides improvement in knowledge and skills but may also enhance doctors' intrinsic motivation through incentive mechanisms. In addition, our research results complement the study by Klein et al. [4], which emphasizes the application of psychological interventions in medical education, especially in helping medical students cope with medical errors.

At the practical level, our research suggests that hospital managers should consider introducing diversified incentive measures when designing training programs, such as providing career development opportunities and performance rewards, to promote doctors' active participation. At the same time, hospitals should establish continuous evaluation mechanisms to monitor training effectiveness and adjust training content and methods based on feedback. This aligns with the Training-Training Transition (T3D) model proposed by Gordon et al. [14], which emphasizes the importance of continuous support and evaluation in the training process.

Although our research provides valuable insights, there are some limitations. For example, our model assumes that doctors and clinical departments are bounded rational, which may simplify the complex decision-making process in reality. Future research could adopt more complex game models, considering more decision-making factors, such as doctors' personal values and cultural differences between departments. In addition, our research is mainly based on theoretical analysis, and future empirical research can further verify the model's predictions and explore the actual effects of different incentive mechanisms.

6. Conclusion

This study applies evolutionary game theory to construct a comprehensive model aimed at analyzing the game process of hospital-provided training, clinical departments accepting training, and newly recruited doctors participating in training. Our research confirms the key role of hospitals in providing training, revealing the decision-making logic and focus of both parties in the game under different scenarios. Through in-depth analysis of the dynamic game equilibrium strategies (ESS) under nine different scenarios, we draw the following main findings:

(1) In the absence of hospital-provided training, clinical departments lack the motivation to provide skills training for newly recruited doctors, and newly recruited doctors also lack the enthusiasm to participate in training. This indicates that without external incentive mechanisms, training participation is significantly affected.

(2) When hospitals provide training and implement incentive measures, the training participation strategies of clinical departments and newly recruited doctors change. In this case, clinical departments and newly recruited doctors will choose to participate in training only when the net benefit of not accepting training is not enough to compensate for the potential benefits brought by training. This emphasizes the importance of incentive measures in promoting training participation.

(3) To increase the willingness of clinical departments to accept training and newly recruited doctors to participate in training, we suggest the following countermeasures: Hospitals should increase penalties while reducing the cost for clinical departments to accept training, and increase the

opportunity cost of not accepting training. In addition, hospitals should focus on the efficiency and effectiveness of training, ensuring that training content matches actual work needs to substantially improve the skill levels of newly recruited doctors. At the same time, clinical departments should share the benefits of training with newly recruited doctors, incentivizing them to actively participate in training through measures such as increasing the salaries of trained doctors.

Acknowledgments

The authors gratefully acknowledge the financial support provided by the Project from Chengdu Science and Technology Bureau (Grant No. 2023-RK00-00160-ZF) for this research work.

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