Gaming Strategies of Tutors in Guiding Students' Learning Under the Herd Effect

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Abstract. The construction of an excellent learning atmosphere is one of the key focuses for universities in implementing educational policies. Investigating the role of university counselors in fostering such an atmosphere has significant research value. This paper, grounded in the theory of herd behavior, initially employs evolutionary game theory. It then constructs a tripartite evolutionary game model consisting of college students, student leaders, and university counselors to discuss the system's evolutionary stable equilibrium points. Through numerical simulations, the paper analyzes the impact of herd behavior on the strategic choices of the three parties. Finally, empirical research is conducted to validate the model's effectiveness. The research findings provide guidance for promoting the cultivation of a learning atmosphere in universities. Analysis and empirical research confirm that, under the influence of herd behavior, college students exhibit significant mimicry in their learning behaviors towards student leaders. Additionally, the educational management level of counselors, efficient learning methods among students, and the implementation of appropriate rewards and punishment measures can effectively promote active learning among college students.

Keywords: Construction of learning style; Herd effect; Evolutionary gaming; Student leaders; Active learning.

1 Introduction

The construction of an academic atmosphere, as a fundamental project in higher education, reflects a university's values and exerts a subtle guiding influence on students. University counselors, as front-line workers in higher education institutions, play a crucial role in fostering an excellent learning atmosphere, which is one of their nine major responsibilities. Given their frequent and profound interactions with college students, how to effectively guide students to engage in autonomous learning and develop a good academic atmosphere has gradually become a key research topic for many counselor educators.

In the existing literature, scholars have largely approached this topic from a qualitative perspective. Chen[1] emphasizes the basic connotations and theoretical foundations of practical education in universities, conducting empirical research in different

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types of universities to reveal issues such as imbalances in the operation of practical education mechanisms, unequal dynamics, unsatisfactory integration and coordination, and imperfect assessment and feedback systems, providing empirical support for mechanism improvements, and pointing out the practices of university students in practical education. In recent years, some scholars have also studied from a quantitative evolutionary game theory perspective. Li et al.[2-4] focused on the evaluation of ideological and political education for college students, proposing optimized structures for the evaluation index system through extensive data collection and experimentation. Tian et al.[5-6] established a dynamic evolutionary game model involving management departments, teachers, and students, offering decision-making suggestions for high-quality teaching development in universities through simulation and sensitivity analysis. Jin et al.[7-9] constructed an evolutionary game model between an efficient regulatory mechanism and postgraduate students' learning behavior strategy choices, analyzing the strategy selection of postgraduate students under different reward and punishment conditions and concluding that an appropriate reward and punishment coefficient can enhance the quality of postgraduate education to a certain extent. Du et al.[10] synthesized research findings from psychology, sociology, and economics to analyze the current status and causes of college students' herd behavior and propose suggestions on how to strengthen and improve ideological and political education in universities. These studies provide strong support for this paper's research but also have their limitations.

Building upon the research of these authors and combining the practical work of counselors, universities can establish supervision teams centered around university counselors within college communities or classes. The primary role of this supervisory group is to oversee student leaders, including student party members, class and group officers, and ordinary college students. The supervisory group is tasked with rewarding active learners, such as by publicizing their achievements and recognizing exemplars, and penalizing passive learners, such as through self-inspection and corrective measures.

Against this backdrop, this paper employs herd behavior theory to construct an evolutionary game perspective involving college students, student leaders, and university counselors. Using MATLAB for numerical simulations, it analyzes the strategic behavior of each entity's influence on cultivating an excellent academic atmosphere in universities and proposes corresponding countermeasures and suggestions.

2 Modeling

2.1 Problem Descriptions and Assumptions

Assumption 1.

The college student group learning game model consists of three subjects: college students, student leaders, and college counsellors, and stipulates that all three subjects are finite-rational participating subjects, and that the strategy choices gradually stabilise to the optimal strategy over time.

Assumption 2.

College students are the participating subjects 1, the strategy space is $\alpha = (\alpha_1, \alpha_2)$ = (active learning, passive learning), college students choose active learning with a probability of x, passive learning with a probability of $(1 - \mathrm{x})$, and $x \in [0,1]$; student leaders are the participating subjects 2, the strategy space is $\beta = (\beta_1, \beta_2)$ = (active learning, passive learning), student leaders choose active learning with a probability of y, passive learning with a probability of $(1 - \mathrm{y})$, and $y \in [0,1]$; and college counsellors are the participating subjects 3, the strategy space is $\gamma = (\gamma_1, \gamma_2)$ =(strict supervision, lax supervision), college counsellors choose (strict supervision with a probability of z, lax supervision with a probability of $(1 - \mathrm{z})$, and $z \in [0,1]$;

Assumption 3.

College students gain $E_1$for active learning and $E_2(E_1 > E_2)$ for passive learning, student leaders gain E_3 for active learning and $E_4(E_3 > E_4)$ for passive learning, and student leaders have an exemplary role in the learning process, which is quantified as gain E_5.

Assumption 4.

Students consume time cost C_1 for active learning and $C_2(C_1 > C_2)$ for passive learning, and college counsellors consume time cost C_3 for strict supervision of students and $C_4(C_3 > C_4)$ for lax supervision of students.

Assumption 5.

There is a herd effect between college students and student leaders, where college students gain psychological utility gains U when their behaviour is consistent with that of their primary leaders, and college counsellors gain psychological bias selection utility O when college students and student leaders choose the same strategy due to the herd effect.

Assumption 6.

College counsellors quantify gain E_6 for strict supervision of target completion, gain $E_7(E_6 > E_7)$ for lax supervision of target completion, and gain E_8 for recognition of college students who actively learn the theory, gain $E_9(E_9 > E_8)$ for recognition of key leaders who actively learn the theory, and punishment for students who passively learn the theory due to the "law is not responsible for the masses" mindset. The penalty C_5 is imposed when only one party chooses passive learning, and the penalty is imposed when both parties choose passive learning. When both parties choose passive learning, then penalty $C_6(C_5 < C_6)$ is imposed.

From the above assumptions, the three-party game payment matrix can be obtained as shown in Table 1.

Table 1. Tripartite game payment matrix

student leaders			college counsellors	
			strict supervision	lax supervision
College students	active learning	active learning	$E_1 - C_1 + E_8 + U, E_3 - C_1 + E_5 + E_9,$ $E_6 - C_3 - E_8 - E_9$	$E_1 - C_1 + U, E_3 - C_1 + E_5,$ $E_7 - C_4 + O$
		passive learning	$E_1 - C_1 + E_8, E_4 - C_2 - C_5,$ $E_6 - C_3 - E_8 + C_5$	$E_1 - C_1, E_4 - C_2, E_7 - C_4$
	passive learning	active learning	$E_2 - C_2 - C_5, E_3 - C_1 + E_5 + E_9,$ $E_6 - C_3 + C_5 - E_9$	$E_2 - C_2, E_3 - C_1 + E_5, E_7 - C_4$
		passive learning	$E_2 - C_2 - C_6 + U, E_4 - C_2 - C_6,$ $E_6 - C_3 + 2C_6 + O$	$E_2 - C_2 + U, E_4 - C_2, E_7 - C_4$

2.2 Solution of evolutionary stabilisation strategies

Based on the three-party game payment matrix, the expected return function of college students under the strategies of active and passive learning is calculated. The expected payoff for college students choosing active learning is $E_x = yz(E_1 - C_1 + E_8 + U) + y(1-z)(E_1 - C_1 + U) + (1-y)z(E_1 - C_1 + E_8) + (1-y)(1-z)(E_1 - C_1)$.

The expected benefit of college students choosing passive learning is: $E_{1-x} = yz(E_2 - C_2 - C_5) + y(1-z)(E_2 - C_2) + (1-y)z(E_2 - C_2 - C_6 + U) + (1-y)(1-z)(E_2 - C_2 + U)$.

Based on the above equation, the dynamic equation of the evolutionary game replication for university students is obtained as:

$$F(x) = \frac{dx}{dt} = x(1-x)(E_x - E_{1-x}) = x(1-x)(-C_1 + C_2 + yzC_5 - yzC_6 + zC_6 + E_1 - E_2 + zE_8 + 2yU - U). \quad (1)$$

The expected benefits of student leaders choosing active learning are: $E_y = xz(E_3 - C_1 + E_9 + E_5) + x(1-z)(E_3 - C_1 + E_5) + (1-x)z(E_3 - C_1 + E_5 + E_9) + (1-x)(1-z)(E_3 - C_1 + E_5)$.

The expected benefits of a key leader choosing passive learning are: $E_{1-y} = xz(E_4 - C_2 - C_5) + x(1-z)(E_4 - C_2) + (1-x)z(E_4 - C_2 - C_6) + (1-x)(1-z)(E_4 - C_2)$.

Based on the above equation, the dynamic equation for the evolutionary game replication of the main leaders is obtained as:

$$F(y) = \frac{dy}{dt} = y(1-y)(E_y - E_{1-y}) = y(1-y)(-C_1 + C_2 + xzC_5 - xzC_6 + zC_6 + E_3 - E_4 + E_5 + zE_9). \quad (2)$$

The expected benefit of choosing strict supervision for college counsellors is $E_z = xy(E_6 - C_3 - E_8 - E_9) + x(1-y)(E_6 - C_3 - E_8 + C_5) + (1-x)y(E_6 - C_3 + C_5 - E_9) + (1-x)(1-y)(E_6 - C_3 + 2C_6 + O)$.

The expected benefit of choosing lenient supervision for college counsellors is $E_{1-z} = xy(E_7 - C_4 + O) + x(1-y)(E_7 - C_4) + (1-x)y(E_7 - C_4) + (1-x)(1-y)(E_7 - C_4)$.

Based on the above equations, the dynamic equation for the evolutionary game replication of college counsellors is given as:

$$F(z) = \frac{dz}{dt} = z(1-z)(E_z - E_{1-z}) = z(1-z)(-C_3 + C_4 - 2xyC_5 + xC_5 + yC_5 + 2xyC_6 - 2xC_6 - 2yC_6 + 2C_6 + E_6 - E_7 - xE_8 - yE_9 - xO - yO + O) \quad (3)$$

A replicated dynamic equation system for college students, student leaders, and college counsellors as:

$$\begin{cases} F(x) = x(1-x)(-C_1 + C_2 + yzC_5 - yzC_6 + zC_6 + E_1 - E_2 + zE_8 + 2yU - U) \\ F(y) = y(1-y)(-C_1 + C_2 + xzC_5 - xzC_6 + zC_6 + E_3 - E_4 + E_5 + zE_9) \\ F(z) = z(1-z)\begin{pmatrix} -C_3 + C_4 - 2xyC_5 + xC_5 + yC_5 + 2xyC_6 - 2xC_6 - 2yC_6 \\ +2C_6 + E_6 - E_7 - xE_8 - yE_9 - xO - yO + O \end{pmatrix} \end{cases} \quad (4)$$

According to the equilibrium theory, making$F(x) = F(y) = F(z) = 0$yields the pure-strategy local stability point (0,0,0), (10,0), (0,1,0), (0,0,1), (1,1,0), (1,0,1), (0,1,1), (1,1,1) and the mixed-strategy equilibrium point (x^*, y^*, z^*). According to the literature [7]-[8], it can be known that the asymptotically stable solution (x^*, y^*, z^*) of the replicated dynamical system of the multi-population evolutionary game must be a strict Nash equilibrium, and thus in this paper, we need to consider and analyse only eight pure-strategy equilibrium points.

3 Sensitivity Analysis

3.1 Stability Analysis of Equilibrium Points of a Three-way Evolutionary Game System

Based on the replicated dynamic equations of each party's game subject, the Jacobi matrix of the corresponding system is obtained, and the stability of the equilibrium point is analysed by the Jacobi matrix.

Using Lyapunov's law: when all eigenvalues of the Jacobi matrix have negative real parts, the equilibrium point is asymptotically stable. Analyse the stability of each equilibrium point as shown in Table 2.

Table 2. Eigenvalues of Jacobi matrix

Equilibrium	Eigenvalue 1	Eigenvalue 2	Eigenvalue 3	Condition	Stability
(0,0,0)	$C_2 - C_1 + E_3 - E_4 + E_5$	$C_2 - C_1 + E_1 - E_2 - U$	$C_4 - C_3 + 2C_6 + E_6 - E_7 + O$	$(+,-,+)$	instability
(0,1,0)	$C_2 - C_1 + E_1 - E_2 + U$	$C_1 - C_2 - E_3 + E_4 - E_5$	$C_4 - C_3 + C_5 + E_6 - E_7 - E_9$	$(+,-,\times)$	instability
(0,0,1)	$C_3 - C_4 - 2C_6 - E_6 + E_7 - O,$	$C_2 - C_1 + C_6 + E_1 - E_2 + E_8 - U$	$C_2 - C_1 + C_6 + E_3 - E_4 + E_5 + E_9$	$(-,\times,+)$	instability
(0,1,1)	$C_3 - C_4 - C_5 - E_6 + E_7 + E_9$	$C_2 - C_1 + C_5 + E_1 - E_2 + E_8 + U$	$C_1 - C_2 - C_6 - E_3 + E_4 - E_5 - E_9$	$(\times,+,-)$	instability
(1,0,0)	$C_2 - C_1 + E_3 - E_4 + E_5$	$C_1 - C_2 - E_1 + E_2 + U$	$C_4 - C_3 + C_5 + E_6 - E_7 - E_8$	$(+,+,-)$	instability
(1,1,0)	$C_1 - C_2 - E_3 + E_4 - E_5$	$C_1 - C_2 - E_1 + E_2 - U$	$C_4 - C_3 + E_6 - E_7 - E_8 - E_9 - O$	$(-,-,-)$	ESS
(1,0,1)	$C_3 - C_4 - C_5 - E_6 + E_7 + E_8$	$C_1 - C_2 - C_6 - E_1 + E_2 - E_8 + U$	$C_2 - C_1 + C_5 + E_3 - E_4 + E_5 + E_9$	$(\times,\times,+)$	instability
(1,1,1)	$C_3 - C_4 - E_6 + E_7 + E_8 + E_9 + O$	$C_1 - C_2 - C_5 - E_3 + E_4 - E_5 - E_9$	$C_1 - C_2 - C_5 - E_1 + E_2 - E_8 - U$	$(+,-,\times)$	instability

Note: $\times$ symbol indicates uncertainty, $+$ symbols indicate positive eigenvalues, and $-$ symbols indicate negative eigenvalues.

Corollary: When condition $C_1 - C_2 - E_3 + E_4 - E_5 < 0, C_1 - C_2 - E_1 + E_2 - U < 0, C_4 - C_3 + E_6 - E_7 - E_8 - E_9 - O < 0$ is satisfied, there exists a stable point (1,1,0) for the replicated dynamical system.

4 Numerical Simulation of a Three-way Evolutionary Game

4.1 Parameterisation

In order to intuitively demonstrate the influence of various factors on the three-party evolutionary game process and evolutionary results, MATLAB was used to simulate and analyse the game process of behavioural choices of college students, student leaders and college counsellors in different initial participation situations, and the factors were reasonably assigned values by inviting experts from the school and referring to some of the literature [4-5] $E_1 = 15; E_2 = 14; E_3 = 18; E_4 = 16; E_5 = 10; E_6 = 10; E_7 = 9; E_8 = 7; E_9 = 8; C_1 = 10; C_2 = 9; C_3 = 9; C_4 = 7; C_5 = 4; C_6 = 5; U = 6; O = 5$.

4.2 Simulation Analysis

4.2.1 The Evolutionary Impact of the Cost of Time Consumed by Students for Active Learning.

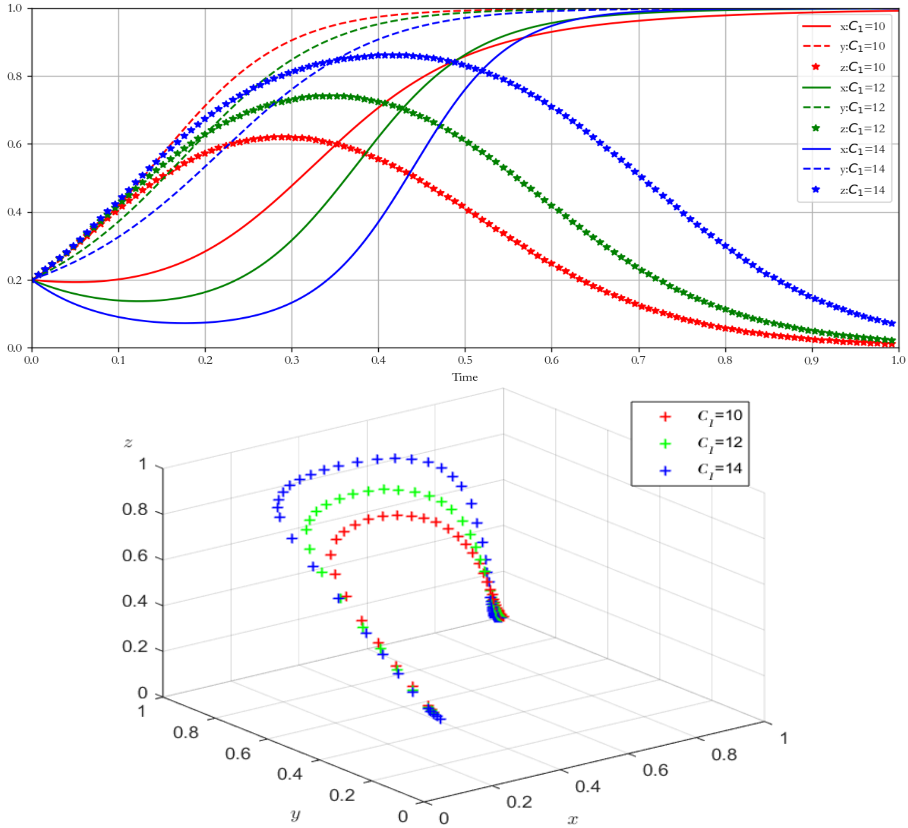

Fig. 1. Impact of changes in the cost of time consumed by students for active learning on evolutionary outcomes

Figure 1 shows the time costs of student active learning at 10, 12, 14. As the system evolves, the convergence to stability for students slows with increasing time costs, while college counsellors' participation willingness increases. Higher learning time costs can speed up the evolution towards active learning among students, increasing their probability of choosing it. Simulations suggest that students initially prefer passive learning due to high costs, but under strict supervision, they eventually opt for active learning.

4.2.2 The Evolutionary Impact of Active Learning Gained by College Students.

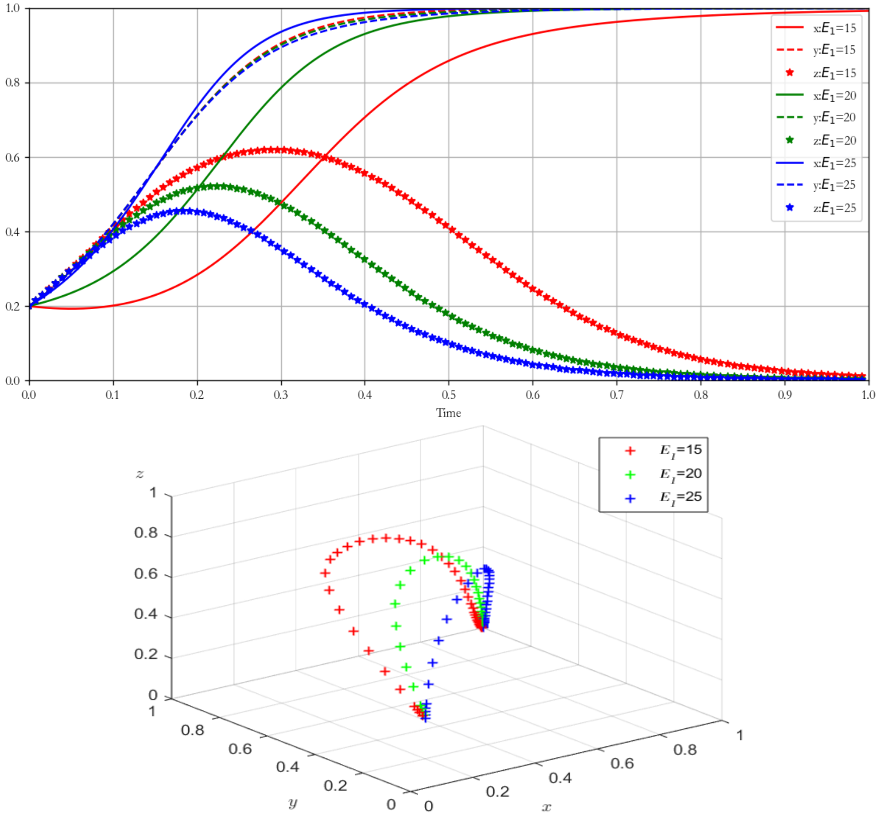

Fig. 2. The effect of gaining gains in active learning theory on evolutionary outcomes for university students

Figure 2 assigns active learning theory gains for college students as 15, 20, 25. With increased gains, student willingness to participate rises; low probabilities of choosing active learning strategies prompt counsellors to adopt strict supervision. Simulations indicate that enhancing learning theory gains effectively promotes active learning strategies among students. Thus, enhancing teaching abilities, diversifying teaching methods, and boosting student engagement are key to improving active Civic learning.

4.2.3 The Evolutionary Impact of Gains from Rigorous Supervision by College Counsellors.

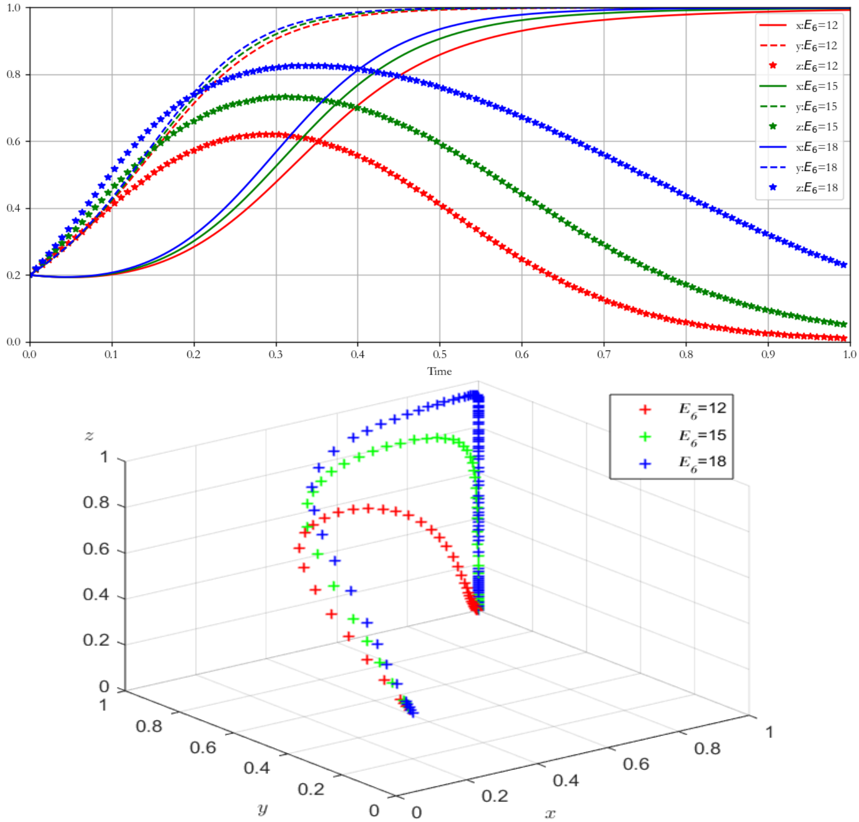

Fig. 3. Impact of changes in gains from strict supervision by college counsellors on evolutionary outcomes

Figure 3 assigns gains from strict supervision for college counselors as 12, 15, and 18. With increased gains, both college students and student leaders tend to stabilize faster. This indicates that higher counselor gains from supervision favor the strict supervision strategy, while students and leaders opt for active learning for gain equilibrium. As the system evolves, the probability of counselors choosing strict supervision rises with their increased motivation, until students stabilize on active learning, after which counselor motivation for strict supervision declines. Counselor supervisory gains significantly affect system evolution, with low gains reducing counselor willingness to participate.

4.2.4 Evolutionary Impact of Implementing Recognition for Active Learning Student Leaders.

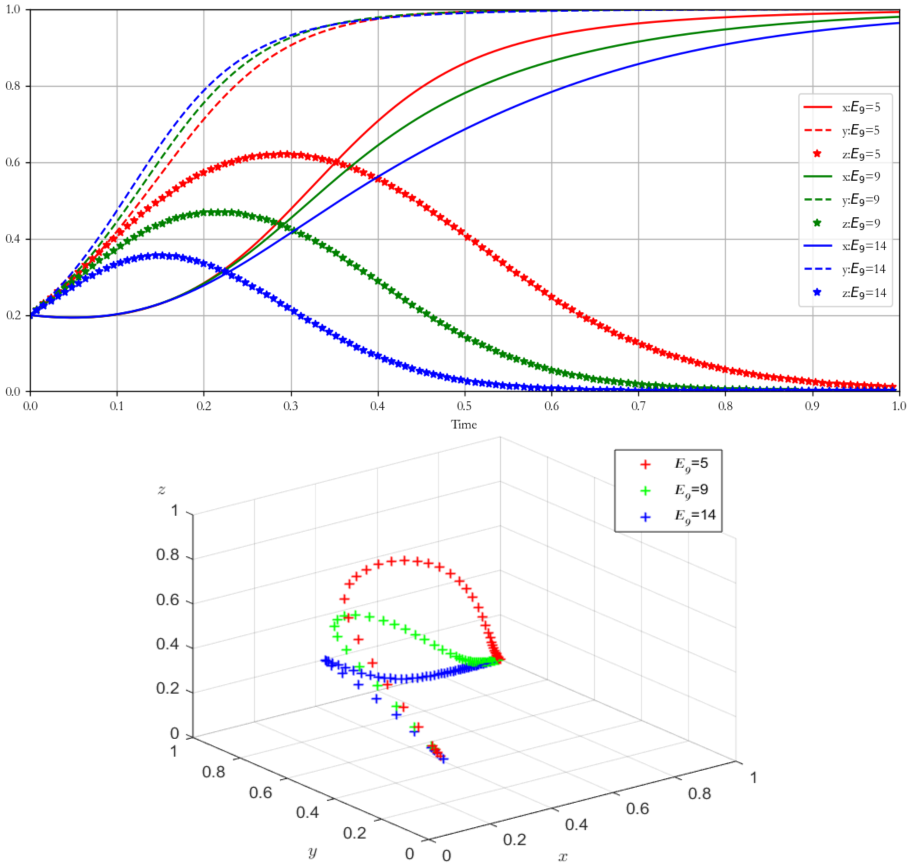

Fig. 4. Impact of implementing changes in recognition gains on evolutionary outcomes for student leaders who are active learners

Figure 4 assigns recognition gain values for active learning student leaders as 5, 9, and 14. With increased recognition gains, stabilization rates rise for both counselors and students. This indicates that higher recognition for active learning leaders leads counselors to prefer lenient supervision, while students become less willing to participate under its influence. As the system evolves, the probability of counselors choosing strict supervision and students choosing passive learning strategies increases. Thus, the level of recognition for student leaders significantly affects the evolution process. Excessive recognition can increase supervision costs and reduce counselor willingness to participate, slowing down the convergence to active learning. Conversely, too little recognition diminishes the herd utility among students. Therefore, developing a reasonable reward and punishment system is crucial.

4.2.5 Evolutionary Influences on the Psychological Utility of Student Groups.

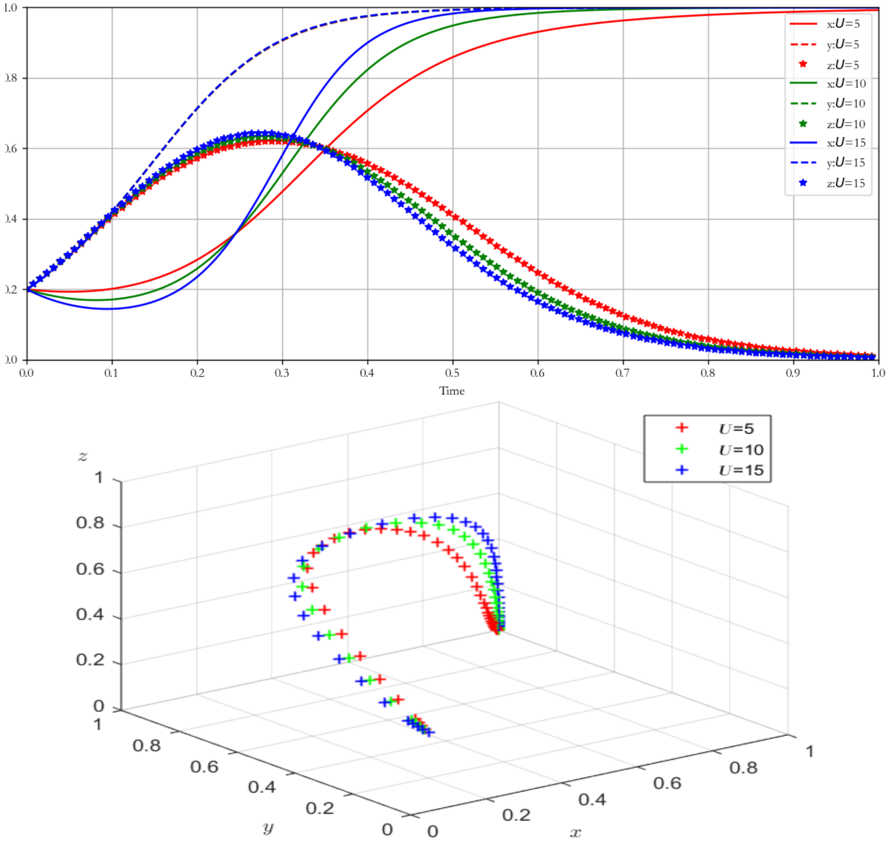

Fig. 5. Effect of changes in psychological utility of student groups on evolutionary outcomes

Figure 5 assigns psychological utility values of 5, 10, and 15 to the student group. As the student group's psychological utility increases, stabilization strategies for college counselors and students first slow and then accelerate. Initially, counselors are more likely to choose strict supervision, while students increasingly opt for active learning. This indicates that in the early evolution, low participation willingness among student leaders leads to a higher probability of passive learning and influences counselors to choose strict supervision. As student leaders' participation willingness rises, the herd effect becomes more pronounced, positively influencing students to choose active learning, and counselors shift towards more lenient supervision. Thus, student leaders' participation and learning enthusiasm significantly impact the student body, and mobilizing their enthusiasm can promote active learning among college students.

4.2.6 Evolutionary Impact of Tripartite Subjects.

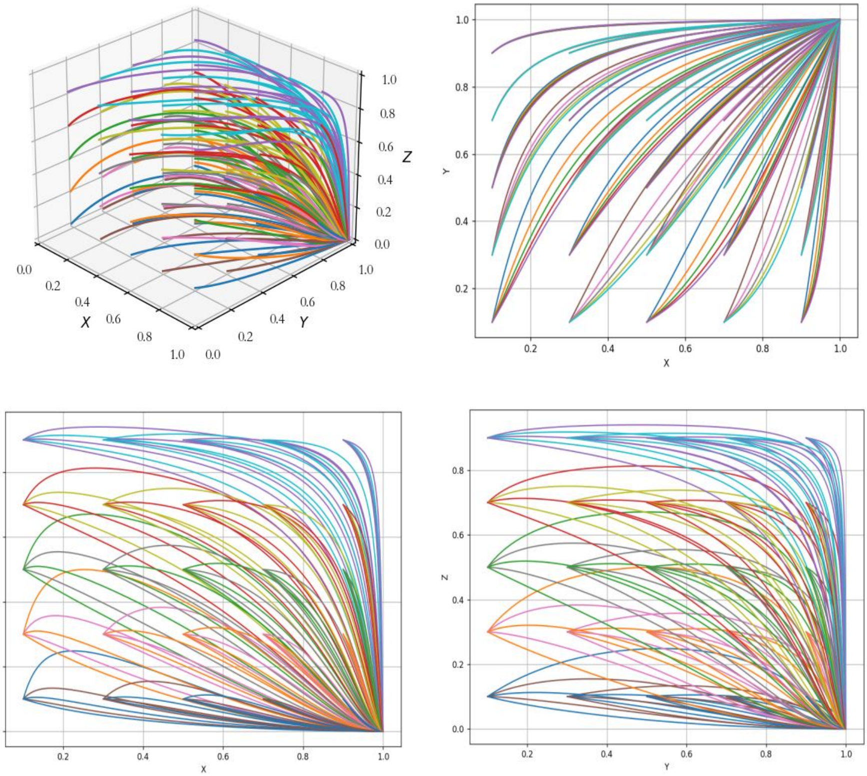

Fig. 6. Evolutionary impact of tripartite subjects

As shown in Figure 6, the simulation results of the three-party subject participation willingness over time evolution show that there exists an evolutionary equilibrium point (1,1,0) in the system, i.e., the three-party strategy combinations of college students, student leaders, and college counsellors (active learning, proactive learning, and lenient supervision). Therefore, colleges and universities should play the key role of student leaders in promoting the active learning of college students, leading college students to the development of the strategy of active learning, and driving the motivation of college students to study, and should also enrich the learning life of college students, increase the interest of college students in learning, and facilitate the development of college counsellors to the development of the strategy of lax supervision. It can be seen that the simulation analysis is consistent with the analysis and research of the stability strategies of all parties, which is of guiding significance to the research of college students' civic education.

5 Conclusion

1. In the learning atmosphere system of college students, student leaders, as guides, transmitters and mobilisers, have a significant influence on other students. Through the effective use of reward and punishment mechanisms and supervision strategies, college counsellors are able to promote student leaders and student groups to achieve the desired learning status. The active learning behaviour of student leaders can drive the active learning of other students through the group effect.

2. Colleges and universities should provide good learning environments and resources, including optimised curricula, innovative practice projects and academic lectures, in order to stimulate students' interest in learning and their sense of active learning. At the same time, college counsellors should establish a good cooperative relationship with student leaders to jointly promote students' learning motivation.

3. The exemplary role of student leaders and the moderate supervision of college counsellors are the keys to promoting active learning among college students. By increasing student leaders' enthusiasm for learning and providing a relatively relaxed learning environment, it can effectively promote college students' choice of active learning strategies.

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