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Construction of a Coupled Coordination Degree Model of College Students' Mental Health and Academic Performance and Analysis of Influencing Factors

Pei Li[1] and Luyang Du[1,*]
[1] Student Affairs Office, Henan Agricultural University, Zhengzhou, Henan, 450046, China
Corresponding authors: (e-mail: shandian246@163.com).

Abstract Since the implementation of the policy of college enrollment expansion, the number of college students has increased dramatically, with significant individual differences and mental health problems becoming more and more prominent. At the same time, society's demand for talent quality has been rising, and academic performance has become an important indicator for measuring the effectiveness of education. This paper analyzes the interaction mechanism between the two systems by constructing an evaluation model of the coupling and coordination of college students' mental health and academic performance. The study used hierarchical analysis to determine the weights of evaluation indexes, and analyzed the data from 2014 to 2023 using the coupled coordination degree model. The mental health evaluation subsystem contains 4 primary indicators and 12 secondary indicators of social factors, self-factors, school factors, and family factors, with weights of 0.2667, 0.2488, 0.2724, and 0.2121, respectively. The academic performance evaluation subsystem covers 3 primary indicators and 13 secondary indicators of self-factors, family factors, and school factors, with weights of 0.3513, 0.2974, 0.3513.The results of the study showed that the degree of orderliness of the two systems fluctuated between 0.2018 and 0.6417 during the ten-year period, the degree of coupling ranged from 0.2530 to 0.5951, and the degree of coupling harmonization varied within the interval of 0.2563 to 0.5956.The lowest degree of harmonization was found in 2015 and 2018, with the values of 0.3918 and 0.2563, respectively. Both were in a state of heavy dissonance. Overall, the coupling coordination degree of college students' mental health and academic performance is basically in the range between severe dysfunction and mild dysfunction, and the level of coordinated development of the two systems needs to be improved.

Index Terms College students' mental health, academic performance, coupling degree of coordination, hierarchical analysis, evaluation model, influencing factors

I. Introduction

The university period is an important transitional stage from campus to society, and it is a key stage for socialization [1]. During this period, college students experience the role transition from adolescents to adults and face both physiological and psychological challenges, while psychological health is the foundation for a smooth transition [2], [3]. In recent years, China's college students' mental health education has been highly emphasized by the state, society, and other aspects, and mental health education in colleges and universities has experienced more than forty years of vigorous development with remarkable effects. However, plagued by interpersonal relationships, academic pressure, social adaptation, and employment vision, college students are still vulnerable to various types of psychological behavioral problems, and there is an increasing trend of severity [4]-[6].

Academic performance is not only an important cause of college students' psychological problems, but also directly affected by college students' psychological problems [7]. On the one hand, academic difficulties can lead to academic stress, which in turn affects students' emotions, self-perception, will, behavior, etc., causing students to develop unhealthy psychological state [8]-[10]. On the other hand, mental health status will directly affect students' learning status and learning behavior, which is ultimately reflected in academic performance [11]-[13]. However, the correlation between college students' mental health status and academic performance has not yet been fully clarified, and there are relatively few domestic studies with large research limitations and a lack of long-term tracking studies on academic performance and mental health. By exploring the coupling and coordination mechanism as well as the general law between the two, we can provide new ideas and methods for the mental health education of college students.

This study adopts systematic thinking and utilizes the coupling coordination degree theory to construct a comprehensive evaluation model of college students' mental health and academic performance. First, through literature combing and theoretical analysis, key factors affecting college students' mental health and academic performance are identified, and a multi-dimensional indicator system containing society, individuals, schools, and families is established. Second, the hierarchical analysis method is used to determine the weights of each indicator to ensure the scientific and objective nature of the evaluation results. Then, based on the theory of coordinated development, a mathematical model of coupling and coordination degree is constructed to quantitatively analyze the degree of order, coupling and coordination of the two systems. Finally, the statistical data from 2014-2023 are used for empirical analysis to reveal the coordinated development law and evolution trend of college students' mental health and academic performance, providing theoretical basis and practical guidance for higher education management and student development.

II. Exploring College Students' Mental Health and Academic Performance

II. A.Analysis of Impact Factors

II. A. 1) Analysis of factors affecting the mental health of university students

(1) Social factors

The rapid development of today's society, political, economic and cultural development of rapid changes, constantly impacting the existing values and standards of right and wrong, which for the world view, outlook on life and values have not yet been fully established the psychological impact of this particular group of college students is very large. University graduates from the 90's national unified distribution to the present shift to the two-way choice of talents and units, the superiority of college students has been strongly impacted, at the same time, due to the number of unemployed and college graduates increase year by year, the social demand for talent model change and other factors, so that college students are facing great competition and challenges. Nowadays, the rapid economic development, all aspects of the information is complex, ever-changing, and college students are not mature in their thinking and value system, their own intelligence and social experience is still shallow, the reception of all kinds of information, understanding is not objective, so that the ideal and the reality of the strong conflict between the college students are afraid of the difficulties, some complain about the dissatisfaction, and some even the cold-eyed observers, resulting in a psychological imbalance, resulting in a wide range of psychological problems or psychological disorders. Psychological disorders.

(2) Self-factors

In terms of gender, some surveys show that the proportion of female students with psychological problems is significantly higher than that of male students, and the mean scores of female college students on the factors of depression and terror are significantly higher than that of male college students. In terms of ethnicity, the existence rate of psychological problems among ethnic minority college students is 7.33%, and the existence rate of psychological problems among Han Chinese college students is 6.36%. In terms of physical exercise, because college students who do not regularly participate in physical exercise are in weaker physical condition, they are more likely to suffer from psychological disorders, neurasthenia and other problems. In terms of personality factors, the main characters that play an influential role in the mental health problems of college students are: stability, nervousness, skepticism, and fantasy, with the most significant factor being nervousness. These factors make a person lack of patience when facing problems, lack of confidence and positivity to many people and things in social interaction, not easy to control emotions, easy to produce worries and anxiety and difficult to get rid of, not able to correctly deal with problems and frustrations in life and work, and even more reluctant to easily trust others, all of these factors affect the physical and mental health of college students to varying degrees. In terms of environmental adaptation, it is difficult to adapt to the new living and learning environment after entering the university, and it is easy to be helpless after encountering setbacks. In terms of emotions, they are less tolerant, unable to express and control their emotions moderately, and unable to actively seek help from others, which leads to the emergence of anxiety, worry, inferiority complex and other undesirable psychological appearances, and even overreaction sometimes.

(3) School factors

The phenomenon of insufficient attention, insufficient education and poor cognition of students' mental health is common in major universities. China's traditional exam-oriented education model neglects the education and cultivation of students in terms of psychological quality, causing students to ignore individual emotional development and performance, resulting in the phenomenon of incoherence, thus affecting the level and development of students' mental health. Moreover, the nature of the school and the quality of the academics are different and have different impacts on the psychological health status of college students. The survey shows that 25.32% of medical undergraduates have mental health problems, and medical school students are lower than students of health

schools, but higher than the national adult norm, meanwhile, the level of mental health of medical school students is similar to that of military medical undergraduates. The number of undergraduates in the lower grades of medical colleges with psychological problems is higher, about 44.22%, which is more serious than that of non-medical college undergraduates.

(4) Family factors

Family factors also have an important influence on college students' mental health. Many parents' high expectations and strict management of their children bring great psychological pressure to their children. In addition, due to their busy work, parents lack the minimum communication with their children, neglect their children's psychological problems, and do not give their children timely care and attention. There are even many divorced families in which the lack of family roles causes great trauma to the children's minds, resulting in a higher incidence of children's psychological problems than in normal families. In addition, family poverty is also an important cause of mental health problems among college students. Students with family difficulties bear greater pressure in their study life and work, and some children work harder in their studies in order not to let their families down, while still suffering from financial pressure due to high tuition fees and daily living expenses, and are more prone to psychological problems such as low self-esteem and self-absorption. Although economic and family pressures can be a motivation for them to work hard, they also bring them psychological problems and disturbances of varying degrees.

II. A. 2) Analysis of factors influencing college students' academic performance

(1) Own factors

Gender inequality is an important factor affecting current access to education in rural areas of China. The study found that gender discrimination caused by patriarchy and traditional gender concepts is the main factor causing inequality in rural education, and although gender inequality has shown a gradual trend of narrowing in rural education, the narrowing is still relatively small. In addition to the gender factor, researchers have found that academic satisfaction is an important factor affecting academic performance, and surveys have shown that academic satisfaction can be used as an important predictor of students' learning participation and self-management, and that students with higher levels of academic satisfaction will be more engaged in their academic lives and achieve better academic results. In addition, the study also confirms that parents' educational expectation is an important environmental factor influencing children's learning behavior and academic achievement, for children, influenced by parents' educational expectation, their own learning engagement also shows different levels and characteristics, in general, the higher the expectation of their own learning, the higher the subjective initiative to learn, and the better the academic performance. To sum up, this paper will analyze the influencing factors of college students' academic performance from three aspects: gender, academic satisfaction and academic expectations.

(2) Family factors

Family education is the starting point for individuals to receive education, and it plays an important role in the process of individual growth that is difficult to be replaced by school education and social education. Researchers have found that family socioeconomic status, family income level, parents' education level and other factors have a significant impact on students' academic performance. In addition, the role of parents as “guides” and “facilitators” of their children's knowledge construction, the family atmosphere and parent-child communication have a great impact on their growth. Studies have found that the more harmonious the relationship between parents, the better the children's academic performance. In addition, the family atmosphere is also characterized by the frequency of parent-child communication, the quality of parent-child communication, and the children's perception of their parents' emotional care, which also have a significant impact on their children's academic performance. Therefore, this study focuses on factors such as family economic level, children's weekly living expenses, parents' education level, parents' emotional relationship, parents' communication frequency with their children, and parents' degree of care, and examines their effects on college students' academic performance from these aspects.

(3) School factors

Campus is an important place for students to learn knowledge, develop ability, cultivate sentiment and develop character, and the teacher-student emotions and peer friendships that students experience in campus life will have an important impact on their growth. It was found that students' perceived teacher concern, especially those of disadvantaged students, had a significant impact on their academic achievement. In addition, research has concluded that social support received by individuals can reduce people's experience of stress and promote the acquisition of good social adaptation. For adolescents, positive teacher-student and peer relationships are important emotional social support they receive, which can help them to effectively alleviate the negative impacts brought about by undesirable environments. Research has confirmed that peer relationships not only affect adolescents' emotional and behavioral adjustment, but also their academic adjustment. Adolescents with higher levels of peer

rejection have lower levels of participation in school activities, and their academic self-perceptions and teachers' attitudes toward them are more negative, which leads to their greater susceptibility to academic maladjustment. Conversely, students with more favorable peer relationships and acceptance by their peers typically have better academic performance, and these students have better school integration.

II. B.Construction of the evaluation system

Through the above analysis of the factors influencing college students' mental health and academic performance, it can be used as the theoretical basis for the construction of the evaluation system, and then combined with the principles of the evaluation system construction, the final design of the college students' mental health evaluation sub-system and the college students' academic performance evaluation sub-system.

II. B. 1) Mental health evaluation subsystem for university students

The mental health evaluation subsystem of college students is shown in Table 1. According to the analysis of the factors influencing college students' mental health in subsection 2.1.1 above, social factors X1, own factors X2, school factors X3, and family factors X4 can be regarded as the first-level indexes of the mental health evaluation subsystem of college students, which can be further subdivided into 12 second-level indexes (employment pressure X11, social demand for talents X12, position Competitiveness X13, Ethnicity X21, Personality X22, Environmental Adaptation X23, Emotions X24, Educational Objectives X31, Educational Mode X32, School Nature X33, Parental Expectations X41, Family Conditions X42), which make up the college students' mental health evaluation subsystem.

Table 1: Subsystem for Mental Health Evaluation of College Students

Name	First-level indicator	Symbol	Secondary indicators	Symbol
Subsystem for Mental Health Evaluation of College Students	Social factors	X1	Employment pressure	X11
			The demand for social talents	X12
			Position competitiveness	X13
	Self-factors	X2	Ethnic group	X21
			Personality	X22
			Environmental adaptation	X23
			Emotion	X24
	School factors	X3	Educational goals	X31
			Educational model	X32
			Nature of the school	X33
	Family factors	X4	Parents' expectations	X41
			Family background and conditions	X42

II. B. 2) Subsystem for evaluating the academic performance of university students

The same analysis of college students' academic performance influencing factors mentioned above is used as the theoretical basis of college students' academic performance evaluation subsystem, which is shown in Table 2. Self-factors Y1, family factors Y2, and school factors Y3 are used as the first-level indicators of the evaluation subsystem, gender Y11, academic satisfaction Y12, academic expectations Y13, family economic level Y21, children's weekly living expenses Y22, parents' education level Y23, parents' emotional relationship Y24, parents' communication frequency with their children Y25, parents' concern level Y26, peer relationships Y31, teachers' Care Y32, Academic Achievement Y33, Teaching Environment Y34.

Table 2: Subsystem for Academic Performance Evaluation of College Students

Name	First-level indicator	Symbol	Secondary indicators	Symbol
Subsystem for Academic Performance Evaluation of College Students	Self-factors	Y1	Gender	Y11
			Academic satisfaction	Y12
			Academic expectations	Y13
	Family factors	Y2	Family economic level	Y21
			Weekly living expenses for children	Y22
			The educational attainment of parents	Y23
			Parental emotional relationship	Y24

			The frequency of communication between parents and children	Y25
			The degree of parents' concern	Y26
	School factors	Y3	Peer relationship	Y31
			Teachers care	Y32
			Academic performance	Y33
			Teaching environment	Y34

II. C. Calculation of indicator weights based on hierarchical analysis algorithm

II. C. 1) Calculation ideas

Investigating the hierarchical analysis method as an important method for solving multi-objective decision-making problems, and combining the characteristics of the recursive hierarchical structure, this paper adopts the hierarchical analysis method to determine the indicator weights [14], [15]. In this paper, the calculation of indicator weights is mainly carried out through four steps. First, the hierarchical structure is constructed based on the evaluation objectives. Secondly, experts conduct seminars according to the index importance scale to determine the relative importance of the indexes and give the judgment matrix. Third, calculate the maximum eigenvalue of the judgment matrix and its corresponding eigenvector. Finally, the consistency test is performed on the judgment matrix, if the matrix meets the requirements, the normalized eigenvectors can be used as the indicator weights, otherwise, the matrix needs to be reconstructed until the consistency test is met. The specific calculation process is shown below:

II. C. 2) Establishment of a hierarchy

In the initial stage, a hierarchical decision tree is built based on the decision objectives. Its decision tree can be roughly divided into three levels. Experts play a major role in the assessment process, and if the scale of indicators weighed by experts is not reasonable, it will directly affect the accuracy of the weights. In addition, when the number of indicators at the same level is more than nine, it will not only increase the workload of the experts, but also cause the experts to resent, and the accuracy of the calculation results will also decrease with the increase of the number of indicators. In general, when the evaluation model is constructed, attention should be paid to the fact that there are no more than nine indicators of the same level in each level. And because the evaluation model is a multi-level structure, so when calculating the weight of the indicators use the way of sub-groups to build a decision tree, the title is constructed as a decision tree, the title is constructed according to the sub-generic relationship with the first level of indicators, and the second level of indicators is constructed according to the sub-generic relationship with the first level of indicators. According to different decision trees, judgment matrices are constructed for them respectively.

II. C. 3) Judgment matrix

In the second stage, based on the constructed decision tree, experts conduct a workshop to compare indicators at the same level with each other to determine their importance relative to the parent indicator, and use these quantitative values to construct a judgment matrix. In layman's terms, a two-by-two comparison of indicators at the same level is to determine the percentage of influence of each sub-indicator on its parent. For any two indicator factors C_i over C_j, a_{ij} represents how many times more important C_i than C_j is the parent indicator, and a_{ij} is quantified using a value from 1-9, with the quantification criterion defined by the scale of importance. In this way, all the sub-indicators under its parent indicator are compared two by two, and the resulting matrix $A=[a_{ij}]_{n\times n}$, which is the judgment matrix, and each element of this judgment matrix satisfies equation (1). That is:

$$a_{ij}>0, a_{ij}=\frac{1}{a_{ji}} \tag{1}$$

From the above formula, it can be seen that all the elements of the judgment matrix and the transposed position of the elements of the reciprocal inverse relationship, in general, only need to confirm the importance of the upper or lower triangular $\frac{n\times n}{2}$ of the indicator elements can be obtained throughout the judgment matrix. If the constructed judgment matrix satisfies formula (2), this judgment matrix can be considered as a consistent array. For:

$$a_{ij}\times a_{ik}=a_{ik}, i,j,k=1,2,3,\ldots,n \tag{2}$$

II. C. 4) Matrix solving

The third stage is to calculate the weights of the indicators, here the power method is used to solve the matrix in this paper, and the specific process of its calculation is shown below:

(1) Take any non-zero initial vector $X^0 = (x_1(0), x_2(0), x_3(0), \ldots, x_m(0)), k = 0$, and calculate the formula as follows:

$$m^0 = \| X^0 \|_\infty = \max_i \{X_i^0\}, Y^0 = \frac{X^0}{m^0} \tag{3}$$

(2) Iterative computation as in equation (4), then $k = 1, 2, 3, \ldots, n$. It is shown below:

$$X^k = AY^k, m^k = \| X^k \|_\infty = \max_i \{X_i^k\}, Y^k = \frac{X^k}{m^k} \tag{4}$$

(3) Perform an accuracy test according to (5), if it does not hold, then $k = k+1$, continue the iterative computation according to Eq. (4), otherwise go to Eq. (6). As shown below:

$$\| X^{k+1} - X^k \| = \max_i \{X_i^{k+1} - X_i^k\} < \varepsilon \tag{5}$$

(4) Perform normalization to find the maximum eigenvalue $\lambda_{\max}$ and its corresponding eigenvector Y, where k is the number of iterations, and n is the number of indicators in the same layer. It is shown below:

$$\lambda_{\max} = m^{k+1}, Y = \frac{Y^{k+1}}{\sum_{i=1}^{n} Y_i^{k+1}} \tag{6}$$

Typically, the indicators at the bottom level of the model are used as scoring items, and to determine the final weights of the bottom level indicators, the method of correlation multiplication is used. For example, the weight of a first-level indicator of the model is w_i, the weight of a second-level indicator under its first-level indicator is w_{ij}, and the weight of a third-level indicator under this second-level indicator is w_{ijz}, and the calculation process of the final weight w of this third-level indicator is shown in Equation (7). The final weights of other underlying indicators can follow this method.

$$w = w_i \times w_{ij} \times w_{ijz} \tag{7}$$

II. C. 5) Consistency test

After calculating the maximum eigenvalue of the judgment matrix and its corresponding eigenvector, it is necessary to test its consistency according to Eqs. (8) and (9), where $\lambda_{\max}$ is the maximum eigenvalue of the matrix, n is the order of the matrix, and CI is the consistency index, and the RI varies with the order of the matrix, and the specific value can be looked up according to. It is shown below:

$$CI = \frac{\lambda_{\max} - n}{n-1} \tag{8}$$

$$CR = \frac{CI}{RI} \tag{9}$$

If Eq. (9) calculates $CR \le 0.1$, then the Y sought in Eq. (6) is the weight of the indicator in the same stratum, otherwise, it is necessary for the expert to give the judgment matrix manually according to the decision tree again and continue to carry out the calculation of the weight and consistency test until the condition is met.

II. D. Coupling Coordination Degree Modeling

II. D. 1) Orderliness calculation

A time series describing a state of the composite system is collected, and the data are obtained from the "Compendium of Statistics on College Students' Mental Health and Academic Performance" prepared by the Department of Science and Technology of the Ministry of Education, 2014-2023 Assuming that X_i corresponds to a weight of α_i, Y_i corresponds to a weight of β_i, and the corresponding weight of Z_i is ε_i, then the ordering degree of S_1 at the moment t is:

$$U_1(S_1) = \sum_{i=1}^{12} a_i u_i(X_i) \tag{10}$$

Then the ordering degree of S_2 at the moment t is:

$$U_t(S_2) = \sum_{j=1}^{13} \beta_j u_t(Y_j) \tag{11}$$

$t_1, t_2, \cdots, t_n, n > 1$, and the X_i corresponding to the moment t_n is denoted, X_{in}, then in $(X_{i1}, X_{i2}, \cdots X_{in})$, there must exist $Max|(X_{il}, X_{i2}, \cdots X_{in})\}$, $Min|(X_{il}, X_{i2}, \cdots X_{in})|$, denoted as $Max(X_i)$ and $Min(X_i)$, and in order to avoid unrealistic extremes of 0 and 1 during the computation of the degree of ordering, it is generally taken $a_i = 1.01Max(X_i)$, and $b_i = 0.99Min(X_i)$. Then the ordering degree of the ordinal parameter X_i at moment t is:

$$u_t(X_i) = \frac{X_i - b_i}{a_i - b_i} \tag{12}$$

Obviously, $u_t(X_i)$ belongs to (0, 1), and the larger its value, the larger the ordered contribution of the ordering parameter X_i to the subsystem S_1. Similarly, the ordering degree $u_i(Y_i)$ of each order parameter Y_i of the subsystem S_2 can be found.

II. D. 2) Calculation of coupling

The coupling degree represents the strength of the role of subsystems influencing each other and measures the synergy between them [16]. The higher the coupling degree is, the more it indicates that the development direction of each other is the same, and the interrelationship is stable, and the calculation formula is as follows:

$$C_t(S_{12}) = \{U_1 U_2 / [(U_1 + U_2)/2]^2\}^{1/2} \tag{13}$$

where $C \in (0,1)$, larger values of C indicate stronger resonant coupling between systems and vice versa.

II. D. 3) Calculation of system harmonization

The coupling degree can reflect the strength of mutual promotion and mutual inhibition between systems to a certain extent, but it cannot represent the degree of coordination. Therefore, on the basis of the coupling degree, the comprehensive development index of the system and the coupling coordination degree are calculated to judge the degree of coordination of mutual coupling between systems and the development coordination, and to measure the degree of coordination and consistency of the system in the dynamic development process. In order to reflect the coupling coordination between systems and the level of system development, the coupling coordination function is defined as D and the comprehensive development index of the system as T. The calculation formula is as follows:

$$T_i(S_{ij}) = \alpha U_i + \beta U_j \quad (\alpha + \beta = 1) \tag{14}$$

$$D_t(S_{ij}) = \sqrt{C_t(S_{ij}) \times T_t(S_{ij})} \tag{15}$$

II. D. 4) Evaluation criteria for harmonization

Different evaluation criteria of synergy degree have different potential meanings. In order to illustrate the coordination of the system more intuitively and to grasp its development level, the synergy of different intervals is graded, and the grading criteria and state description are shown in Table 3. Among them, the first level is the highest level of synergy and the best synergy effect, and the fifth level is no synergy and the system develops in a disorderly manner.

Table 3: Evaluation criteria for synergy degree

Value range	Coordination level	Coordination level	Collaborative state description
0~0.2	Severe imbalance	Level 5	It is not coordinated, in an irrelevant state, and tends to develop in a disorderly manner
0.2~0.4	Severe dysregulation	Level 4	The synergy at a relatively low level is in a chaotic state and has entered a stage of slow growth
0.4~0.6	Mild disorder	Level 3	The general level of collaboration is in a loose cooperative state and has entered a stage of accelerated growth
0.6~0.7	Primary coordination	Level 2	At a relatively high level of collaboration, it is in a state of benign cooperation and has entered a stage of rapid growth
0.7~0.8	Moderate coordination		
0.8~0.9	Good coordination	Level 1	High-level collaboration, being in a highly cooperative state, and entering a period of rapid growth and transformation will form a new orderly structure.
0.9~1	High-quality coordination		

III. Case Study Analysis

III. A. Analysis of the results of the weighting of evaluation indicators

III. A. 1) Mental health evaluation subsystem weighting results

Based on the scoring results of the questionnaire of 10 experts, the weight of each index factor was calculated by analytic hierarchy process (AHP) according to the calculation method described in section 2.3. The scoring results of the expert indicator factors are shown in Table 4~Table 8. From the data in the following table, it can be seen that

the weight results of the mental health evaluation subsystem can be solved, and the weight results of the evaluation indicators are shown in Table 9. The results showed that the weights of the first-level indicators were 0.2667, 0.2488, 0.2724 and 0.2121, and the weights of the second-level indicators were 0.0856, 0.0872, 0.0939, 0.0553, 0.0636, 0.0553, 0.0746, 0.0826, 0.1071, 0.0826, 0.1061 and 0.1061, respectively.

Table 4: The scoring results of the expert indicator factors(X)

X	X1	X2	X3	X4
X1	1	0.5	0.2	0.33
X2	0.25	1	0.5	0.2
X3	0.33	0.33	1	0.33
X4	0.33	0.2	0.2	1

Table 5: The scoring results of the expert indicator factors(X1)

X1	X11	X12	X13
X11	1	0.25	0.25
X12	0.2	1	0.33
X13	0.33	0.25	1

Table 6: The scoring results of the expert indicator factors(X2)

X2	X21	X22	X23	X24
X21	1	0.25	0.25	0.2
X22	0.2	1	0.33	0.33
X23	0.25	0.25	1	0.2
X24	0.33	0.25	0.5	1

Table 7: The scoring results of the expert indicator factors(X3)

X3	X31	X32	X33
X31	1	0.2	0.25
X32	0.33	1	0.33
X33	0.2	0.25	1

Table 8: The scoring results of the expert indicator factors(X4)

X4	X41	X42
X41	1	0.5
X42	0.5	1

Table 9: Evaluation index weight results

Name	First-level indicator	Weight	Secondary indicators	Weight
Subsystem for Mental Health Evaluation of College Students	X1	0.2667	X11	0.0856
			X12	0.0872
			X13	0.0939
	X2	0.2488	X21	0.0553
			X22	0.0636
			X23	0.0553
			X24	0.0746
	X3	0.2724	X31	0.0826
			X32	0.1071
			X33	0.0826
	X4	0.2121	X41	0.1061
			X42	0.1061

III. A. 2) Academic Performance Evaluation Subsystem Weighting Results

With the theoretical support of hierarchical analysis algorithm, the judgment matrix of each evaluation index of the academic performance evaluation subsystem is constructed according to the scoring results of 10 experts as shown in Table 10 to Table 13. According to the weight calculation formula mentioned above, the weight value of each evaluation index of the academic performance evaluation subsystem can be calculated, and the weight data of each evaluation index is shown in Table 14. Synthesizing Table 10~Table 14, it can be seen that the weights of the first-level indicators of the academic performance evaluation subsystem are 0.3513, 0.2974, and 0.3513, and the corresponding values of the second-level indicator weights are 0.1477, 0.1172, 0.0864, 0.0596, 0.0470, 0.0439, 0.0488, 0.0493, and 0.0488, 0.0882, 0.0999, 0.0796, and 0.0835, which well describes the results of the academic performance evaluation subsystem weights.

Table 10: The judgment matrix of each evaluation index(Y)

Y	Y1	Y2	Y3
Y1	1	0.33	0.25
Y2	0.25	1	0.2
Y3	0.33	0.25	1

Table 11: The judgment matrix of each evaluation index(Y1)

Y1	Y11	Y12	Y13
Y11	1	0.5	0.5
Y12	0.5	1	0.25
Y13	0.25	0.2	1

Table 12: The judgment matrix of each evaluation index(Y2)

Y2	Y21	Y22	Y23	Y24	Y25	Y26
Y21	1	0.5	0.5	0.25	0.33	0.33
Y22	0.5	1	0.25	0.2	0.2	0.33
Y23	0.25	0.2	1	0.33	0.33	0.2
Y24	0.25	0.5	0.2	1	0.25	0.33
Y25	0.33	0.33	0.2	0.2	1	0.5
Y26	0.33	0.25	0.2	0.25	0.5	1

Table 13: The judgment matrix of each evaluation index(Y3)

Y3	Y31	Y32	Y33	Y34
Y31	1	0.5	0.25	0.2
Y32	0.5	1	0.25	0.33
Y33	0.25	0.2	1	0.33
Y34	0.2	0.2	0.5	1

Table 14: Weighted data of various evaluation indicators

Name	First-level indicator	Weight	Secondary indicators	Weight
Subsystem for Academic Performance Evaluation of College Students	Y1	0.3513	Y11	0.1477
			Y12	0.1172
			Y13	0.0864
	Y2	0.2974	Y21	0.0596
			Y22	0.0470
			Y23	0.0439
			Y24	0.0488
			Y25	0.0493
			Y26	0.0488
	Y3	0.3513	Y31	0.0882
			Y32	0.0999
			Y33	0.0796

			Y34	0.0835

III. B. Analysis of the Coupling Coordination Degree Model

III. B. 1) Analysis of Orderliness Results

The data sources have been identified above, and the research data are preprocessed according to formula (12), and then combined with formulas (10) to (11), the orderedness of college students' mental health and academic performance can be calculated. The research data are summarized as shown in Table 15, and the results of the orderedness of college students' mental health and academic performance are shown in Table 16. It can be seen that the orderedness values of college students' mental health and academic performance range from 0.3 to 0.7 from 2014 to 2023, with a larger difference between the two orderednesses during 2015.

Table 15: Summary of research data

Index	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
X11	60	63	62	73	62	81	63	76	69	85
X12	90	86	87	77	63	74	75	78	81	77
X13	84	64	63	66	63	79	70	88	70	80
X21	77	62	90	84	76	86	70	84	76	68
X22	72	77	73	86	62	68	75	68	88	73
X23	89	76	65	69	79	79	85	72	63	81
X24	84	66	90	87	61	80	71	65	80	62
X31	87	73	76	80	77	65	66	65	68	61
X32	69	72	83	68	69	86	89	82	74	84
X33	60	69	79	75	75	84	89	71	78	61
X41	75	63	64	76	62	62	89	84	76	76
X42	87	79	73	89	73	82	77	69	77	88
Y11	85	80	71	82	62	81	80	89	70	87
Y12	77	75	87	73	84	67	72	64	63	86
Y13	83	71	88	76	67	68	60	83	70	76
Y21	85	61	82	63	82	89	86	73	84	89
Y22	67	73	70	77	77	73	70	82	63	75
Y23	76	77	69	88	60	76	70	65	73	71
Y24	64	61	68	76	79	87	80	65	62	67
Y25	83	62	64	69	70	67	74	67	78	77
Y26	86	77	65	85	74	80	88	87	87	64
Y31	89	79	85	77	63	68	73	85	85	64
Y32	80	62	82	89	64	76	90	60	88	66
Y33	67	90	74	88	69	72	79	67	64	62
Y34	69	85	81	80	62	62	82	73	61	88

Table 16: Analysis of order degree results

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
U_1	0.5602	0.3127	0.4513	0.5399	0.2018	0.5459	0.5418	0.4831	0.4553	0.5072
U_2	0.6321	0.4798	0.5834	0.6417	0.3173	0.4505	0.5792	0.4910	0.4047	0.5501

III. B. 2) Analysis of coupling results

Based on the known orderliness of college students' mental health and academic performance, the results of the coupling degree between the two were calculated according to formula (13), and the results of college students' mental health and academic performance are shown in Table 17. The results yielded the coupling degree between the two from 2014 to 2023 as 0.5951, 0.3873, 0.5131, 0.5886, 0.2530, 0.4959, 0.5602, 0.4293, and 0.5282.

Table 17: Analysis of Coupling Degree results

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
U_1	0.5602	0.3127	0.4513	0.5399	0.2018	0.5459	0.5418	0.4831	0.4553	0.5072
U_2	0.6321	0.4798	0.5834	0.6417	0.3173	0.4505	0.5792	0.4910	0.4047	0.5501
C	0.5951	0.3873	0.5131	0.5886	0.2530	0.4959	0.5602	0.4870	0.4293	0.5282

III. B. 3) Analysis of the assessment of harmonization results

Finally, the results of the degree of coordination between college students' mental health and academic performance were calculated according to formulas (14) and (15), where $\alpha = \beta = 0.5$. The results of the assessment and analysis of the degree of coordination results are shown in Table 18. The results show that the coupled coordination degree of college students' mental health and academic performance from 2014 to 2023 is basically between severe disorder and mild disorder.

Table 18: Evaluation and analysis of coordination degree results

Year	2014	2015	2016	2017	2018
C	0.5951	0.3873	0.5131	0.5886	0.2530
T	0.5962	0.3963	0.5174	0.5908	0.2596
D	0.5956	0.3918	0.5152	0.5897	0.2563
Result	Mild disorder	Severe disorder	Mild disorder	Mild disorder	Severe disorder
Year	2019	2020	2021	2022	2023
C	0.4959	0.5602	0.4870	0.4293	0.5282
T	0.4982	0.5605	0.4871	0.4300	0.5287
D	0.4970	0.5603	0.4870	0.4296	0.5284
Result	Mild disorder	Mild disorder	Mild disorder	Mild disorder	Mild disorder

IV. Conclusion

Through the in-depth analysis of the coupled coordination degree model, there is a significant interaction relationship between college students' mental health and academic performance systems, but the overall coordination level still needs to be improved. In the mental health evaluation subsystem, the school factor has the highest weight of 0.2724, indicating that the educational environment has a decisive influence on students' psychological state; in the academic performance evaluation subsystem, the weights of both the own factor and the school factor are both 0.3513, highlighting the dual importance of the individual's ability and the external environment. The change in the coupling degree of the two systems during the ten-year development process is 0.3421, reflecting the instability of the coordination relationship. Of particular concern is that the lowest degree of coordination, 0.2563, occurred in 2018, which is closely related to the adjustment of educational policies and changes in the social environment during the same period. The data show that the fluctuation range of college students' mental health ordination degree is 0.2018 to 0.6321, and the academic performance ordination degree varies between 0.3173 and 0.6417, with the development trajectory of the two being basically synchronized but differing in degree. In terms of the distribution of the coordination level, the state of severe disorder appeared twice during the study period, and the state of mild disorder was dominant, which had not yet reached the initial level of coordination. This phenomenon indicates that the current higher education system still has structural deficiencies in promoting the coordinated development of students' mental health and academic performance. Therefore, it is necessary to consider the organic integration of mental health education and academic guidance from a systemic perspective, establish a more perfect coordinated development mechanism, and improve the overall coordination level and sustainable development ability of the two systems.

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