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Differential equation to verify the validity of the model of the whole-person mental health education activity in Universities

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Abstract

College students are prone to psychological changes and personality distortions under heavy pressure. It will lead to catastrophe if it is not promptly guided or improperly used to reduce stress and relax. Now we integrate holistic education into the construction of the mental health education system in colleges and universities. This is conducive to solving practical problems and improving the effectiveness of system construction. We set up a differential equation model (DCE) based on the discrete choice to study mental health due to practice. At the same time, we adopt the mutual influence model of penetrating dissemination of thoughts and public opinion and human behaviour, and establish the SEIR DCE with constant input and bilinear incidence rate. The experiment verifies the algorithm's effectiveness on the model of whole-person mental health education activities in colleges and universities.

Keywords: differential equation, discrete choice differential equation model, whole-person mental health, mental health education practice.

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1 Introduction

Mental health education in colleges and universities is an integral part of education that improves students' psychological quality and promotes physical and mental health and harmonious development. Colleges and universities must adhere to the combination of heart education and moral education and strengthen humanistic care and psychological counselling [1]. In July 2018, the 'Guideline for Mental Health Education for Students in Colleges and Universities' issued by the Party Group of the Ministry of Education of the Communist Party of China mentioned that mental health education should be carried out for all students. Schools need to be responsible

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for the mental health development of each student and pay attention to individual differences among students. At present, mental health education has formed a ‘four-in-one’ work pattern of education and teaching, practical activities, consulting services and preventive intervention. Colleges and universities have set up compulsory public courses for college students’ mental health education and rely on mental health education centres to provide psychological counselling services. Each and every year newcomers enrol in the school and the school conducts a general psychological test and publicises mental health education in multiple ways. Students know how to help themselves and who to ask for help when they have psychological problems. Universities need to combine their characteristics and actual conditions to create their crisis intervention system. The concept of holistic education is derived from the humanistic view of learning and rooted in natural human nature.

Some scholars believe that the discrete choice differential equation model (DCE) is mainly used to solve the research problem that the explained variable results from qualitative selection and its quantity is discontinuous [2]. DCE can help mental health education researchers establish the relationship between individuals with model characteristics and the probability of their choices. Some scholars believe that the research on students’ anxiety is primarily theoretical and only happens in psychology. From the perspective of economics, we have less research on the use of discrete choice DCEs. Therefore, it is an improvement for us to introduce the discrete choice DCE into the research of mental health education.

2 Discrete choice DCE establishment

2.1 Model establishment

We use questionnaire surveys, psychological consultations, behaviour observations and other forms to analyse students’ ideological conditions. At the same time, we classify college students in school according to their ideological status. Infector Warehouse I: Students accept wrong public opinion and be active. Students often spread out wrong opinion in public. For example, class meetings, peer exchanges, etc. Lurker E: The student is in a period of uncertainty [3]. They are overwhelmed by wrong public opinion, and public opinion affects the everyday life of the individual. Susceptible warehouse S: The students have weak ideological awareness and are easily influenced by students in warehouse I. Educator Warehouse R: Students who come out of warehouse I after ideological education. They have ‘immunity’ and spread positive energy.

Because of the absorbent spread of thought and public opinion and the mutual influence of human behaviour, we build an SEIR DCE with constant input and a bilinear incidence rate:

$$\begin{cases} \dot{S} = pA - \beta SI - \mu S \\ \dot{E} = \beta SI - \delta E - \mu E - \varepsilon E \\ \dot{I} = \delta E - \gamma I - \mu I - \varepsilon I \\ \dot{R} = (1 - p)A + \gamma I + \varepsilon I + \varepsilon E - \mu R \end{cases} \quad (1)$$

A is a constant input (the number of new students enrolled each year). μ is the output rate of each warehouse (for example, graduation). δ is the incidence rate from warehouse E to warehouse I . γ is the recovery rate from warehouse I to warehouse R . ε is the student’s self-regulated recovery rate. The model uses bilinear incidence. β is the infection rate coefficient [4]. Where A is a constant, $\mu, \delta, \gamma, \varepsilon, \beta > 0, 0 < p < 1$.

We use the regeneration matrix to calculate the primary regeneration number of the above SEIR model as

$$R_0 = \frac{\beta \delta p A}{\mu(\delta + \mu + \varepsilon)(\gamma + \mu + \varepsilon)} \quad (2)$$

In the transmission model, the reproduction number R_0 represents the average number of people that a communicator I can infect when all the populations are susceptible. Furthermore, we can use the Lyapunov function to prove that R_0 can be used as a threshold for disseminating inadequate information. Therefore, the SEIR, as mentioned above, studies the dissemination of wrong public opinion among college students $R_0 \leq 1$, the influence of

such wrong public opinion will gradually disappear over time under the existing ideological education system. When $R_0 > 1$ the existing ideological education system fails, and the influence of such wrong public opinion will exist for a long time and bring challenges to the ideological development of students. It will seriously distort the students' outlook on life and values [5]. Through the above analysis, we get that R_0 is not only a threshold for whether wrong public opinion is spread but also a standard for evaluating the ideological health of college students and the ideological education system of colleges and universities.

2.2 Simulation parameter analysis

Through observation and analysis, the parameters that affect the primary regeneration number R_0 are $\mu, \varepsilon, \delta, \gamma, \beta$. Since μ is the proportion of output students, it is no longer within the management scope of colleges and universities, so I will not discuss it here. Below we discuss the impact of other parameters on R_0 . We calculate the partial derivative of R_0 concerning the above parameters and get:

$$\begin{aligned}\frac{\partial R_0}{\partial \beta} &= \frac{pA\delta}{\mu(\delta+\mu+\varepsilon)(\gamma+\mu+\varepsilon)} \frac{\partial R_0}{\partial p} = \frac{A\beta\delta}{\mu(\delta+\mu+\varepsilon)(\gamma+\mu+\varepsilon)} \\ \frac{\partial R_0}{\partial \delta} &= \frac{pA\beta(\mu+\varepsilon)}{\mu(\gamma+\mu+\varepsilon)(\delta+\mu+\varepsilon)^2} \frac{\partial R_0}{\partial \gamma} = -\frac{pA\beta\delta}{\mu(\delta+\mu+\varepsilon)(\gamma+\mu+\varepsilon)^2} \\ \frac{\partial R_0}{\partial \varepsilon} &= -\frac{pA\beta\delta(\delta+\gamma+2\mu+2\varepsilon)}{\mu(\delta+\mu+\varepsilon)^2(\gamma+\mu+\varepsilon)^2}\end{aligned}\quad (3)$$

Easy to know

$$\frac{\partial R_0}{\partial \beta} > 0, \frac{\partial R_0}{\partial p} > 0, \frac{\partial R_0}{\partial \delta} > 0, \frac{\partial R_0}{\partial \gamma} < 0, \frac{\partial R_0}{\partial \varepsilon} < 0 \quad (4)$$

Based on the mathematical analysis of the SEIR mentioned above propagation model, what we have to do is to try to reduce R_0 by increasing γ and ε , and reducing β , δ and p . We make the primary reproduction number < 1 to ensure that the influence of such wrong public opinion gradually disappears among college students.

2.2.1 Increase the recovery rate from warehouse I to warehouse R

The thinking of students in the warehouse is affected by wrong public opinion, and the externalisation behaviour of such students can quickly form a window-breaking effect in the collective [6]. This makes more and more students to have wrong thoughts and abnormal behaviours, which brings disadvantages to the management of colleges and universities. To deal with such students, we need to take personal conversations and psychological counselling to understand the defects and deficiencies of wrong public opinion correctly. Educational guidance is the central link that promotes the healthy development of students' thoughts. Ideological education has particular pertinence. We can use proper measures to effectively control the scope of influence and increase the recovery rate γ . This will enable students to gain immunity and then transition to the warehouse R.

2.2.2 Increase the self-recovery rate of students ε

People have a particular self-regulation mechanism when they have problems. This is mainly focused on the choice, cognition and adjustment of learning goals. Carrying out diligence and excellence activities among students can create positive progress, making every student have a sense of crisis. This can promote the rapid growth of students into qualified personnel for military construction [7]. In addition, special attention should be paid to cultivating and establishing advanced models among students to set up a tangible example force around most students. The power of role models can guide students to resist wrong public opinion and give full play to their advantages, thereby increasing the student's self-recovery rate ε .

2.2.3 Reduction coefficient p , infection rate coefficient β and morbidity coefficient δ

The influence of family and society plays a crucial role in forming and developing students' thoughts. Therefore, it is necessary to understand students' family relations and to lead social relations. This can understand the students' basic situation and lay the foundation for good communication [8]. We use the local armed forces department and the college entrance examination and admissions office to do an excellent job in the political

review work to find out the actual situation of each student. This will improve the quality of enrolment, and at the same time, the coefficient p is reduced.

The first-year students who have just finished the college entrance examination and walked behind the university gate to be ignorant and curious about new theoretical ideas. At the same time, they are also easy to accept wrong public opinion so that most first-year students will enter the susceptible warehouse S . For the freshmen group in the warehouse S of the susceptible, the school often organises 2–3 months of enrolment and intensive training. The intensive training lasts for 2–3 months to strengthen the essential quality of freshmen students and the level of military training [9]. Further, improve students' ideological awareness and help students form correct thinking habits. This method can improve students' resistance to wrong public opinion. In addition, the closedness of training also indirectly implements protection and isolation for new students, reducing their contact with older students in the warehouse I . These practices can make students increase their awareness of vigilance and subconsciously reduce the infection rate coefficient β .

3 The experimental steps of the discrete choice DCE

Discrete choice research uses Discrete Choice to choose the experimental model to determine the strategy of practice objects. This can improve the mental health of students. Some scholars believe that the discrete choice DCE first defines the practice of mental health education as a multi-attribute process. Its scope includes the time, content, and follow-up support for the education of mental health education practice objects. Among them, it takes about 4 days, and the content is to select prominent survey subjects. During the experiment, we adopted new propaganda strategies to improve students' mental health [10]. This is mainly considering the change process of the sensitive dimensions of students with different preferences. The concept of preference in decision theory refers to the tendency of decision-makers to choose one of the events or results when faced with several events or results. The main steps are as follows: First, each student can have multiple choices to complete the task. Second, several students were randomly sampled for investigation. Researchers use evidence-based practice to improve mental health. The emergence of evidence-based practice is undoubtedly one of the success stories in the 1990s, which is regarded as a 'paradigm revolution' in medicine and humanities, and social sciences.

4 The enlightenment of discrete choice DCE to mental health education practice

People's views on psychological problems mostly contain subjective judgements and are qualitative variables. The assignment method of the discrete choice DCE is also called a qualitative variable assignment. It is of great significance to the analysis of experimental data of mental health education. It includes an unordered qualitative variable assignment and an ordered qualitative variable assignment. The data assigned to the disordered qualitative variables are equal, parallel and mutually exclusive. Usually, the value is 1 or 0 according to gender, urban and rural areas, an only child, etc. Table 1 shows the explanatory variables and their assignments.

Ordinal qualitative variable assignment refers to the middle or approximate distance between variables. Usually, assignments are 1, 2, 3, 4 and 5. The assignment of qualitative variables must be reasonable to ensure that the meaning of the variables and the analysis of the results are correct. Some scholars have also adopted discrete choices when studying the status of contemporary college students' recognition of mainstream ideology propaganda and education DCE method. They believe that the advantage of this research method lies in the processing of discrete complex advanced multivariate analysis of qualitative data. The variables studied by the discrete choice DCE are discrete, and their values can only be calculated in natural numbers or integer units. It is different from continuous variables. The values of continuous variables are continuous, and two adjacent values can be divided infinitely. The method of qualitative variable assignment is of great significance for the scientific analysis of experimental results.

Table 1 Explain variables and their assignments

Factor classification	Specific factors	Assignment
Personal characteristics	Gender	Female = 0, male = 1
	Urban and rural	Country = 0, Town = 1
	Grade	Freshman, sophomore, junior = 0, senior = 1
	Only child	Only child = 0, non-only child = 1
	Character	Introvert = 0, extrovert = 1
	Temper	Impatient = 0, mild = 1
Social, environmental factors	Affected by the social business climate	Not affected = 0, affected = 1
	Professional literacy (English level, computer level, etc.)	Low = 0, high = 1
	Mass media influence (decadence, pornography, murder, etc.)	Not affected = 0, affected = 1
Campus environment factors	Evaluation of living space	Think very narrow = 0, suitable and spacious = 0
	Think the surrounding noise	Very bad = 0, very good = 1
	Think the campus spiritual civilisation construction	Fortunately = 0, very large = 1

In the practice of mental health education for educators, we use the method of randomly selecting multiple students to select investigators. This makes the test content representative. Some studies have used random cluster sampling to investigate the reading interest of students, parents and teachers. Among them, a stratified random sampling method was used to conduct individual interviews with students. For example, about 82.7% of teachers and parents in their attitudes towards reading think that students in the lower grades of elementary school like it very much, and about 10.9% think they dislike it. Note that 71.7% of teachers and parents thought it was too small in terms of reading volume while 21.2% thought it was moderate, and 7.1% thought it was too much. The data in the questionnaire is distinguished. This facilitates the analysis to draw valid conclusions and avoids the problem of sample bias.

5 Experimental verification

We use the SEIDR model to construct a cellular automata simulation method to simulate the propagation process of wrong information in the social topological network. At the same time, we studied the influence of individual reaction time, mental health education penetration rate and bad information variation on disseminating wrong information. The average number of contacts λ in the Poisson distribution of the social network constructed according to the simulation is the average number of contacts in the network $\lambda \approx 4$. The article assumes that the individual's infection intensity $I_1 = 0.6$ during the incubation period and the infection intensity $I_2 = 0.9$ during the susceptible period.

5.1 The impact of the popularisation rate of mental health education on the dissemination of wrong information

There is no initial immunity (shown in Figure 1(A)). Then assume that all members are randomly immunised, and the number of people immunised is 30% of the total population (shown in Figure 1(B)), 50% (shown in Figure 1(C)) and 90% (shown in Figure 1(D)).

A certain percentage of mental health education can control the spread of wrong information from the simulation results. Figure 1(D) shows that when the popularisation rate of mental health education is not high, insufficient information will start to be controlled. But over time, wrong information will still fluctuate. In this case, the number of transmissions continues to rise after some time. In general, the number of communicators gradually decreases when the popularisation rate of mental health education increases. It can be seen that the small ratio of psychological health education only temporarily controls terrible information, but it cannot eliminate lousy information fundamentally [11]. Therefore, if the lousy information is effectively controlled through psychological health education, a considerable proportion of the population needs psychological health education. Figure 2 reflects the changing law of the number of communicators when the psychological health education rate is 0.1, 0.3 and 0.9, respectively.

This article proposes the concept of targeted injection. We need to purposefully carry out psychological

Fig. 1 The impact of mental health education penetration rate on the dissemination of wrong information.

Fig. 2 Comparison of communicators (the penetration rate of mental health education is 0.1, 0.3, 0.9, respectively).

health education for people who have come in contact with them. This is because the number of nodes in the social network has the most potent destructive effect on disseminating lousy information, which provides us with a new idea for effective prevention. We choose the number of nodes (frequent social interactions) for the target injection (the injection ratio is 0.1). Target injection can significantly reduce the number of people spreading and the effect of controlling the spread of insufficient information is more prominent.

5.2 The impact of education acceptance rate on the dissemination of harmful information

We observe the development trend of wrong information from the change of p_3, p_5 . Under the premise that the anti-bad information education intensity (p_5) is determined, the sensitivity of the number of communicators to the rate of the communicator's receiving education decreases slightly with the increase of the rate of education received (Figure 3). From the time of the outbreak, increasing the rate of education has a noticeable impact on the growth rate of the number of communicators. The greater the education rate, the slower the growth of communicators, and eventually stabilises gradually. Therefore, we need to intervene appropriately while assisting with other control methods.

5.3 The impact of the school's whole-person psychological education level on the dissemination of wrong information

The thesis uses education intensity to reflect the school's whole-person psychological education level, taking

Fig. 3 Impact of education ratio on communicators.

p_5 to take 0.2, 0.5 and 0.9 to get the simulation chart 4. From the results, when the overall psychological education level of the education school is determined (that is, p_3 is always 0.6), when the education level is 0.2, the number of transmissions fluctuates periodically, and the peak value gradually decreases. As the level of education gradually improves, and the anti-bad information education increases to a certain level; it is possible to control the lousy information at first temporarily. The number of disseminators will fluctuate significantly over time. Therefore, the author believes that anti-bad information education should be sufficient enough.

Fig. 4 The impact of education intensity on communicators.

6 Conclusion

This article is based on the differential equation algorithm based on the whole-person education concept and model to stimulate students' enthusiasm for active learning and lifelong learning. Combining with the transmission mechanism of infectious diseases, we can strictly control the quality of enrolment and strengthen the immunity and resistance of students at the source. Special education for 'affected people' is to focus on the analysis of critical issues. Ideological education should be carried out throughout the whole process and be targeted. Furthermore, we need to make a specific analysis of specific issues.

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