Research on the Application of Orthogonal Experimental Design to the Flexible Performance Scoring System for College Ideological and Political Courses

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Abstract. The evaluation of achievements in college ideological and political courses often faces difficulties in quantification, insufficient differentiation, and outdated scoring systems, which are difficult to meet the needs of research-oriented teaching models. This paper comprehensively considers theoretical learning and practical activities, focuses on students' ideological innovation and participation, introduces indicators such as task completion time, and proposes a flexible scoring scheme that integrates contribution values into power calculations. By determining parameters through orthogonal experiment methods, the scoring system fully reflects students' comprehensive mastery and performance in the course, utilizes contribution values for nonlinear processing to enhance the scientificity and rationality of the scoring system. Combining computerized processing to simplify the process and drawing on the game upgrade model to display results, it effectively stimulates students' enthusiasm for learning and spirit of exploration.

Keywords: Orthogonal Experimental Design, Parameter Determination, Flexible Scoring system, Research-oriented Teaching; College Ideological and Political Courses

1 Introduction

Higher education ideological and political courses, as the core courses shaping students' worldviews, outlooks on life, and values, play an important role in talent cultivation. With the promotion of research-based teaching models, the assessment of achievements faces higher requirements. However, the current scoring methods have problems such as strong subjectivity, difficulty in quantification, and insufficient differentiation, making it difficult to fully reflect students' actual abilities and fail to stimulate students' enthusiasm for learning[1][2] .

To address these issues, this paper proposes a flexible scoring scheme. The scheme converts indicators such as students' classroom participation, teamwork, and task completion into contribution values, and integrates power calculation to comprehensively reflect students' academic performance. At the same time, the orthogonal ex-

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periment method is adopted to determine the scoring parameters, abandons the traditional "trial and error" method, enhances the scientificity and reliability of scoring, and encourages students to actively participate in course learning and innovative practice[3].

2 Flexible Scoring Program

Students' regular performance in political education courses will be included in the final grade calculation in the form of contribution values. Students who actively participate in class discussions, propose unique insights, participate in practical activities, and complete tasks in teamwork will receive additional contribution values. An increase in contribution values will reduce the power of the final grade, thereby improving the converted final grade, and motivating students to actively participate in course learning.

The specific calculation formula is as follows:

$$\mathrm{P} = (1 - \mathrm{v})^{c} \tag{1}$$

where v is the rate of development, c is the value of the contribution, and P is the exponent

$$\mathrm{k} = 100/100^{P} \tag{2}$$

(k is the coefficient so that 100 points still maps to 100 points.

$$\mathrm{V} = \mathrm{k} \cdot S^{P} \tag{3}$$

S is the exam grade and V is the final converted grade.

For example, the parameters of three special types of processing functions are calculated as follows:

"Open root times ten" when P is 0.5 and k is 10, $\mathrm{V} = 10 \cdot \sqrt{\mathrm{S}}$

"Regular treatment", P is 1, k is 1, and $\mathrm{V} = \mathrm{S}$

"Square by 100" ,when P is 2 and k is 0.01,$\mathrm{V} = S^2/100$

As shown in Figure 1, "open root times ten" corresponds to an open downward parabola, "regular treatment" corresponds to an oblique line, and "square divided by 100" corresponds to an open upward parabola. In this case, a score of 0 still maps to a score of 0, and a score of 100 still maps to a score of 100.)

The contribution value c corresponds to the level title, using a simple linear relationship. Its impact on the power value P can be adjusted according to the positive or negative value of the contribution: when the contribution value is positive, the impact on the power value is a deceleration process; when the contribution value is negative, it is an acceleration process.

It is possible to introduce a discounted value of contribution C

$$\mathrm{C} = \begin{cases} a_1 \cdot c^{b_1}, c \le 0 \\ a_2 \cdot c^{b_2}, c > 0 \end{cases} \tag{4}$$

a_1 is the conversion factor when the contribution value is negative, and b_1 is the power of conversion when the contribution value is negative.
a_2 is the conversion factor when the contribution is positive and b_2 is the power of conversion when the contribution is positive.

$$P = (1 - v)^C \tag{5}$$

In order to provide students with a clearer picture of their course performance, this paper calculates the required passing score BS in real time by using the student's contribution value, that is, the student's actual course grade of 60, corresponding to the exam score[6].

$$\mathrm{V} = \mathrm{k} \cdot S^P = 60 = k \cdot BS^P \tag{6}$$

In that case, $BS = \sqrt[P]{60/k}$.

Therefore, we have a total of five parameters to be determined by the orthogonal test: “development speed v”, “discount factor for negative points a_1”, “Negative points converted to powers b_1”, “discount factor for positive points a_2”, “positive integral commutative power b_2”.

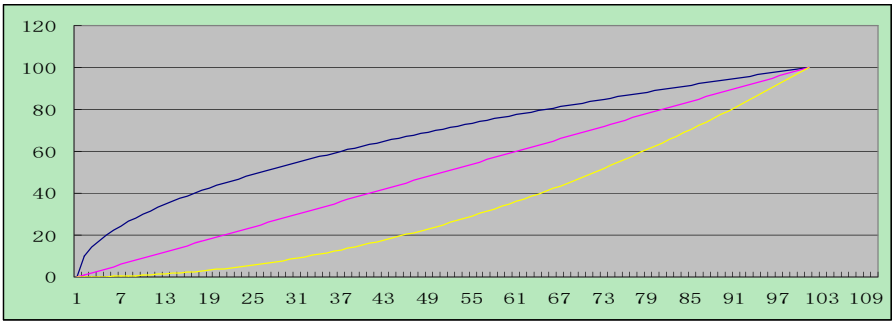

Fig. 1. Three special processing functions.

3 Orthogonal Experiment Method Parameter Determination

The system needs to determine v, a_1, b_1, a_2, b_2, a total of 5 parameters, which are 5 "factors", and all are quantitative controllable factors. These 5 factors are all continuous variables, and we hope the "number of levels" to be as high as possible to ensure that the orthogonal experiment has a high efficiency[7].

Refer to the commonly used orthogonal tables, we choose the 6-factor 5-level $L_{25}(5^6)$ orthogonal table, which can accommodate 6 parameters and has a level number of 5 (higher), as shown in Table 1.

Table 1. $L_{25}(5^6)$Orthogonal tables.

Column number / Test number	1	2	3	4	5	6	CN / TN	1	2	3	4	5	6
1	1	1	1	1	1	1	6	2	1	2	3	4	5
2	1	2	2	2	2	2	7	2	2	3	4	5	1
3	1	3	3	3	3	3	8	2	3	4	4	1	2
4	1	4	4	4	4	4	9	2	5	4	1	2	3
5	1	5	5	5	5	5	10	2	5	1	2	3	4
11	3	1	3	5	2	4	16	4	1	4	2	5	3
12	3	2	4	1	3	5	17	4	2	5	3	1	4
13	3	3	5	2	4	1	18	4	3	1	4	2	5
14	3	4	1	3	5	2	19	4	4	2	5	3	1
15	3	5	2	4	1	3	20	4	5	3	1	4	2
21	5	1	5	4	3	2							
22	5	2	1	5	4	3							
23	5	3	2	1	5	4							
24	5	4	3	2	1	5							
25	5	5	4	3	2	1							

"development speed v", "discount factor for negative points a_1", "negative points converted to powers b_1", "discount factor for positive points a_2", "positive integral commutative power b_2" The arrangement of the 5-factor 5-level table for the 5 parameters is shown in Table 2.

Table 2. Factor levels.

Factors / level	v	a_1	b_1	a_2	b_2
1	0.05	0.8	0.8	0.8	0.5
2	0.06	0.9	0.9	0.9	0.6
3	0.07	1	1	1	0.7
4	0.08	1.1	1.1	1.1	0.8
5	0.09	1.2	1.2	1.2	0.9

$L_{25}(5^6)$ table has 6 columns, and the factors to be considered can be arranged arbitrarily without considering the interaction. The arrangement of the factors is shown in Table 3.

Table 3. Table header design.

Factors	v	a_1	b_1	a_2	b_2
List number	1	2	3	4	5

For the test results, we adopt a comprehensive formula evaluation combined with an intuitive analysis method for analysis and evaluation[4][5]. The specific plan is as follows:

(1) Indicator 1: Negative score indicator

Students with extremely poor performance in political education courses and the highest negative contribution value (such as -20) should have their passing score close to the passing score required for a score of 0 in the normal points system. Taking the average of 10 roll calls in a 48-hour course as an example, the maximum negative value is approximately -20 (violation of discipline, taking the minimum value of "deduct 2 points or divide the existing score by 2").

Under the rigid percentage system, regular grades account for 30%, and exam grades account for 70%. In the worst case, regular grades are 0, the maximum exam score is 70 points, and to pass the total score, the actual exam needs to be:

100×60/70=87.5points

(2) Indicator 2: Positive Score Indicator

For students who think positively and are brave in innovation, and for students with a contribution value of a larger positive number, we should make their passing score approximately equal to the passing score required for full marks in the regular score under a rigid percentage system. Taking the average of 10 active and correct answers in a 48-hour course as an example, the maximum positive value is about +20.

In the rigid percentage system, the best case is that the regular grades are full marks of 30, and when the total score passes, the actual exam needs to be:

$$100\times(60-30)/70=42.9\text{points}$$

(3) Comprehensive formula evaluation

Combine the negative score indicator 1 and the positive score indicator 2 with equal weight, and there can be a comprehensive evaluation formula

$$M_i = [BS(-20) - 85.7]^2 + [BS(20) - 42.9]^2 \tag{7}$$

(The evaluation formula here takes the square instead of the absolute value, which can amplify the impact of deviations)

Based on the header design, replace columns 1, 2, 3, 4, and 5 in table $L_{25}(5^6)$ with the corresponding levels from table 1 according to the factor level table in table 2, thus obtaining the experimental scheme. Fill in the calculated experimental results as shown in Figure 2

At test number 11, M takes the minimum value of 0.796, with the parameters: development speed v=0.07, negative score conversion coefficient a_1=0.8, negative score conversion power b_1=1, positive score conversion coefficient a_2=1.2, positive score conversion power b_2=0.6. At this time, the negative score index is 85.2 (ideal value 85.7), and the positive score index is 42.1 (ideal value 42.9), with an error of about 0.65%. The parameter accuracy meets the requirements (error < 1%), and no further optimization is needed[8].

Listnumber / Testnumber	1	2	3	4	5	6	BS(-20)	BS(20)	M
1	0.05	0.8	0.8	0.8	0.5	1	72.2	54.1333	307.9
2	0.05	0.9	0.9	0.9	0.6	2	77.3	50.9199	135.2
3	0.05	1	1	1	0.7	3	83.3	46.0423	15.8
4	0.05	1.1	1.1	1.1	0.8	4	89.5	38.696	31.77
5	0.05	1.2	1.2	1.2	0.9	5	94.7	28.0253	302.5
6	0.06	0.8	0.9	1	0.8	5	78.3	36.4932	96.54
7	0.06	0.9	1	1.1	0.9	1	84.6	24.6363	334.9
8	0.06	1	1.1	1.1	0.5	2	90.8	50.0287	77.13
9	0.06	1.1	1.2	0.8	0.6	3	95.8	50.2258	155.8
10	0.06	1.2	0.8	0.9	0.7	4	79.8	44.7597	38.56
11	***0.07***	***0.8***	***1***	***1.2***	***0.6***	***4***	***85.2***	***42.1494***	***0.796***
12	0.07	0.9	1.1	0.8	0.7	5	91.6	44.0645	36.25
13	0.07	1	1.2	0.9	0.8	1	96.4	35.1043	175.9
14	0.07	1.1	0.8	1	0.9	2	80.9	22.3632	445.2
15	0.07	1.2	0.9	1.1	0.5	3	86.9	48.1914	29.42
16	0.08	0.8	1.1	0.9	0.9	3	91.9	21.1471	511.7
17	0.08	0.9	1.2	1	0.5	4	96.7	47.6312	144.1
18	0.08	1	0.8	1.1	0.6	5	81.5	41.1292	20.65
19	0.08	1.1	0.9	1.2	0.7	1	87.7	31.5485	132.9
20	0.08	1.2	1	0.8	0.8	2	93.3	34.5427	128
21	0.09	0.8	1.2	1.1	0.7	2	96.8	30.4596	277.5
22	0.09	0.9	0.8	1.2	0.8	3	81.8	17.0163	685.3
23	0.09	1	0.9	0.8	0.9	4	88.1	20.9501	487.8
24	0.09	1.1	1	0.9	0.5	5	93.8	47.3943	85.59
25	0.09	1.2	1.1	1	0.6	1	97.6	40.5574	147.6

Fig. 2. Test plan and results.

4 Parameter Solidification and Operation

Based on Excel, the system requires no programming, is easy to use, highly reliable, and simplifies the process of processing grades. Showcase student performance through a gamified interface to motivate class participation[9]

The parameters are debugged through the "Settings and Descriptions" worksheet, As Figure 3,and the current settings are: development speed 0.07, negative score conversion factor 0.8, negative score conversion power 1, positive score conversion factor 1.2, positive score conversion power 0.6. Points are added for students' behaviors such as answering questions and participating in discussions, while points are deducted for absenteeism and disrupting discipline.

	A		B	C	D	E	F	G	H	I	J
1	Correction coefficient a1		0.8	Correction power b1	1						
2	Correction coefficient a2		1.2	Correction power b2	0.6						
3											
4	converted value	c	20	Number of people	26						
5	Converted value	C	7.241011604	Random numbers	27						
6											
7	Square order	P	0.591268394								
8	Coefficient	k	6.568454737								
9	Passing grade	BS	42.14943918								
10											
11	Score	S	42								
12	Transformation value	V	59.87412958								
13	Round down	FV	60								
14	The current growth coefficient is set to 0.07, the negative score correction coefficient is 0.8, and the negative score correction power is 1.										
15	The coefficient for positive score correction is 1.2, and the power of positive score correction is 0.6, which may be adjusted at the end of the term.										
16	Irregular roll calls, active responses to questions, discussions, and writing papers will all earn contribution points										
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Fig. 3. Setup & Instructions - Parameter Curing.

As shown in Figure 4, each table in the ideological and political course corresponds to a specific class, and each student in the class is represented by a row record.

	A	B	C	D	E	F	G	H	I	J	K
1	9	Name	Contribution value	Technical grade	Examinination	Overall evaluation	0302	0309	0316	0323	0330
2	202121026030	ShuYi Chen	11	Assistant class representative	60	65	1	1	1	1	1
3	202121105001	Jie Wang	11	Assistant class representative	61	66	1	1	1	1	1
4	202121105002	Hao An	11	Assistant class representative	63	74	1	1	1	1	2
5	202121105003	DongJun Chen	23	Thought and politics study backbone	61	68	1	1	2	1	3
6	202121105004	WenQi Chen	10	Assistant class representative	73	76.5	1	1	1	1	1
7	202121105005	YanXin Ding	10	Assistant class representative	60	64.5	1	1	1	1	1
8	202121105006	Da Feng	10	Assistant class representative	90	91	2	1	1	1	1
9	202121105007	Xi Han	13	Thought and politics class representative	88	89.5	1	1	3	1	2
10	202121105008	KaiJie Huang	30	Learning role model	90	92	1	1	1	1	1
11	202121105009	XiaoLan Ji	11	Assistant class representative	77	80	1	1	1	1	2
12	202121105011	XueJian Li	31	Learning role model	68	79	1	1	2	1	1
13	202121105012	RenHuai Liang	11	Assistant class representative	72	75.5	1	1	1	2	1
14	202121105013	KaiGe Liu	15	Thought and politics class representative	89	90.5	2	1	1	1	1
15	202121105014	ChuanKe Lu	15	Thought and politics class representative	70	74.5	1	1	1	1	2
16	202121105015	DongLu Mo	13	Thought and politics class representative	62	74.5	1	1	1	1	1
17	202121105016	FaQing Qiu	18	Thought and politics class representative	62	68	1	1	1	1	1
18	202121105017	HangRui Shen	18	Thought and politics class representative	67	72	1	1	1	1	1
19	202121105018	TengHui Sun	18	Thought and politics class representative	61	67	1	1	1	1	1
20	202121105019	JiaLe Wan	18	Thought and politics class representative	63	69	1	1	1	1	1
21	202121105020	ChengJie Wang	18	Thought and politics class representative	61	67	1	1	1	1	1
22	202121105021	GuoYang Wang	18	Thought and politics class representative	73	77.5	1	1	1	1	1

Fig. 4. Ideological and political class schedule.

Students' contribution values are determined by teachers based on their classroom performance, with points added for behaviors such as answering questions and participating in discussions, and points deducted for behaviors such as absence and disrupting discipline. Contribution values are automatically calculated using Excel formulas, with active students having higher contribution values, lower BS scores, and ultimately higher final grades[10].

Real-time display of contribution values, integrated with the level advancement system (such as new political study students, active members, backbone, model soldiers, and star students), to stimulate students' interest. The total score V is the result of rounding off the flexible transformation of the exam score S, and the passing score is the exam score required when the total score is 60.As for the Excel calculation formula used for the total score V:

=ROUND(POWER(G2,POWER((1- Setup & Instructions!B$1), (SIGN(D2)-1)/2* Seup&Instructions!B$2*POWER(ABS(D2),Setup&Instructions!D$2)+(SIGN(D2)+1)/2*Setup&Instructions!B$3*POWER(ABS(D2),Setup&Instructions!D$3)))*(100/POWER(100,POWER((1- Setup & Instructions!B$1), (SIGN(D2)-1)/2* Setup & Instructions!B$2*POWER(ABS(D2), Setup & Instructions!D$2)+(SIGN(D2)+1)/2* Setup & Instructions!B$3*POWER(ABS(D2), Setup & Instructions!D$3))),0)

5 Conclusion

The scientificity and rationality of evaluating the achievements of college ideological and political courses are crucial to the effectiveness of student learning and the quality of course teaching. This paper proposes a flexible scoring scheme based on orthogonal experiments, comprehensively considering students' classroom performance, and enhancing the scientificity of scoring through the determination of scientific parameters and nonlinear processing of contribution values. Combined with computerization and gamification, the process is simplified, students' enthusiasm is stimulated, and it provides a reference for the reform of ideological and political course evaluation. Subsequent research can further optimize the scheme to serve the education and teaching in colleges and universities.

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