A Flexible Performance Scoring System of Research-Teaching Mode

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Abstract. The research - teaching mode aims to cultivate students' creativity. However, the current scoring system can't reflect students' real knowledge level and isn't suitable for it. Drawing on the "square - root times ten" method, we propose a flexible scoring system for research - teaching. It includes students' contributions in a power function, and we've deduced the formula and given the design. Using computerization, a game - like upgrade mode, and simple display, we implement this system, which enlivens classrooms and promotes extracurricular research.

Keywords: Research-based Teaching, Student Performance, Scoring System

1 Introduction

The research - oriented teaching model, contrasting with the traditional one - way knowledge - transmission mode, aims to cultivate students' creative ability in applying knowledge, observing, posing, analyzing and solving problems [1-3].Research teaching model has gradually come into view[4].The current student evaluation system uses a fixed - ratio (30% daily, 70% exams). Daily scores (25 - 30, rarely changing) can't fully show students' abilities or spur research, not meeting research - teaching needs. Teaching should fit students' traits: seeking individuality, cultivating interest [5].

2 Scheme Design

Therefore, this paper draws on classic methods such as "square - root times ten". It introduces a contribution index, represented by an exponent (e.g., 0.5 - power for square root), to reflect students' knowledge acquisition and then proposes a flexible scoring scheme.

Students actively involved in research, with a positive attitude and good course understanding, get higher contribution values. Higher contribution values mean lower power values. So, for the same test scores, the final processed total score will be higher.

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Integrating computerized processing simplifies grade handling. Inspired by game leveling - up mechanisms, grades are directly shown on the classroom big screen in a straightforward way. This allows students to quickly know their daily learning progress and its impact on final grades.

"Quality Management and Reliability" is a core course for senior undergraduates majoring in Industrial Engineering. Due to its depth and complexity, we selected this course to conduct an experimental study on the research - oriented teaching grading system.

The specific calculation formula is as follows:

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

Where v is the development speed (initially set at 0.07),c is the contribution value, and P is the power.

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

k is a coefficient to make 100 points still map to 100 points.

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

S is for exam score, V is for final converted score.

For example, three typical processing function parameters are calculated as follows: “Taking a root and multiplying by ten”, when P is 0.5 and k is 10, “Regular processing" is performed”, P is 1, k is 1, and “Square divided by hundred” , when P is 2 and k is 0.01,

As depicted in Figure 1, "square - root times ten" is represented by a downward - opening parabola, "regular processing" by an oblique line, and "square divided by hundred" by an upward - opening parabola. Here, a score of 0 remains 0, and a score of 100 remains 100.

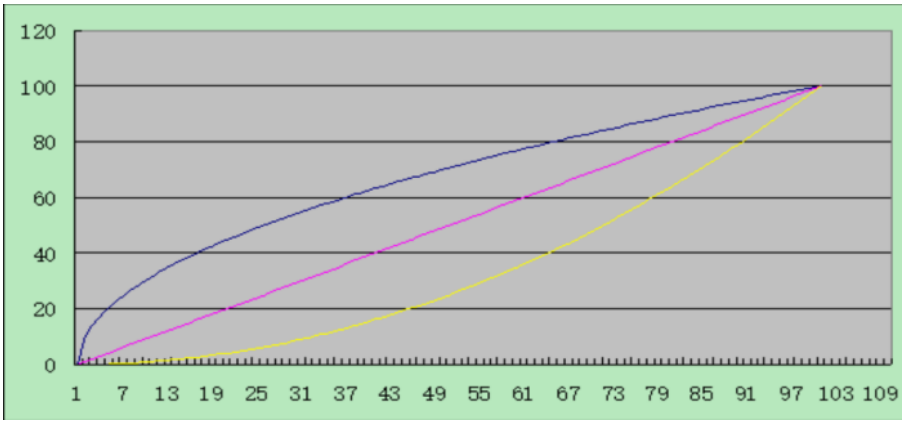

Fig. 1. Three Representative Processing Functions.

3 Expansion Plan

Based on practical needs, this flexible scoring framework can be further expanded and optimized. The contribution value c has a simple linear relation with the rank title, and its impact on the power can be adjusted by the sign (positive or negative) of the contribution values. Specifically, a positive c slows the power's growth, while a negative one speeds it up.

Subsequently, a contribution value, denoted as an equivalent value C, can be introduced.

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

a1 represents the conversion coefficient in the case where the contribution value is negative, and b1 represents the conversion power when the contribution value is negative. a2 serves as the conversion coefficient when the contribution value is positive, while b2 represents the conversion power in the situation where the contribution value is positive. Evidently, when the value of c is equal to zero, the value of C is likewise zero.

In the calculation of the power value P, substitute the contribution value C with its equivalent value C.

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

(The determination of parameters, including the development speed v, the negative - score conversion coefficient a1, the negative - score conversion powerb1; the positive - score conversion coefficient a2, and the positive - score conversion power b2，can be achieved by means of orthogonal experiments and other methods.)

To help students visually understand their performance, we can calculate in real - time the passing score BS needed based on their current contribution value. That is, when the final overall evaluation is 60, what score is required in the exam.

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

$$BS = \sqrt[P]{60/k}.$$

4 System Implementation

The system is carried out based on Excel. Its implementation approach is straightforward, featuring easy maintenance, safety, and reliability. Moreover, it does not necessitate VBA programming.

Each class maps to an Excel worksheet where each student is a row in the table,as illustrated in Figure 2.

Serial number	Student ID	Name	Contribution Value	Level	Passing Score	Exam Score	Final Score	302	305	309	312	Homework 1	Speed 1	Test Speed
1	3	Zhu Xuelian	2	Intern Inspector	57.1	60	63		1	1	1	1.5	0.5	-10
1	6	Gu Cheng	7.5	Assistant Engineer	53.3	71	76		1	1	1	2	1	-7
1	17	Li Chenghao	37.5	Deputy General Manager	41.5	90	94		3	3	1	2	2	10
2	7	Wang Long	23	Quality Supervisor	46.5	85	90		2	2	1	2	1	8
2	9	Chen Xinxin	20	Quality Supervisor	47.6	70	78		3	3	1	1.5	2	1
2	11	Li Chengrui	28.5	Deputy General Manager	44.5	85	90	1	1	1	1	2	0.5	3
2	12	Wang Xiaorong	29.5	Deputy General Manager	44.1	95	97	1	1	1	1	2	1	5
2	19	Chen Xun	16.5	Senior Engineer	49	76	82	1	1	1	1	2	1	1
2	23	Zhu Qian	39	Deputy General Manager	41	80	88	4	1	3	2.5	2	1.5	11
3	11	Chu Shijian	8	Assistant Engineer	53.1	50	57		1	1	1	2	0.5	-5
3	14	Gao Junjie	9.5	Quality Engineer	52.3	55	62		1	1	1	2	0.5	-6
3	24	Chen Xingmeng	19	Quality Supervisor	48	80	86		1	1	1	1.5	0.5	3
3	26	Ji Lei	18	Senior Engineer	48.4	70	78	3	3	1	2	1	1	
3	27	Bao Zongyou	20	Quality Supervisor	47.6	55	66			1	1	2	1	-3
3	29	Ye Junjie	20.5	Quality Supervisor	47.4	65	74	1	1	1	1	2	1	6
3	30	Wang Jie	21	Quality Supervisor	47.2	73	81		1	1	1	2	1	-8
4	7	Xu Nengchao	-2.5	Quality Supervisor	64.6	68	64		1	1	1	1.5	1	-11
4	16	Yao Junyong	-2.25	Quality Supervisor	64.1	55	50		1	1	1	1.5	1	-13
4	17	Zhang Zhen	-5.5		69.5	58	47		1	1	1	2	1	-12
4	18	Liu Xinpeng	-7.25		72.2	55	39		1	1	1	1	1	-12
4	19	Jiang Guojian	10	Quality Engineer	52	80	84	1	1	1	1.5	0.5	-4	
4	24	Zhou Kun	1.5	Intern Inspector	57.5	63	65			1	0.5	1.5	0.5	-9
4	26	Gu Xiaofei	16.5	Senior Engineer	49	86	90	2	2	1	1.5	1	0	
4	28	Chen Cheng	25.5	Quality Supervisor	46.5	90	93	1	1	1	1	2	1	2
4	29	Chen Teng	23	Quality Supervisor	45.9	72	80			1	1	2	1	7
4	30	Yu Lingpeng	7.5	Assistant Engineer	53.3	76	80			1	1	2	1	-1
4	31	Cheng Qiancuo	12	Quality Engineer	51	71	77	1	1	1	2	1	-2	

Fig. 2. List of Students' Achievements.

Students can gain contribution scores via irregular roll - calls, active in - class responses, after - class discussions, and paper - writing. Points will be deducted for violating classroom rules. (Students' answers and in - class performance can be noted in an Excel sheet.)

The contribution values of students at different times are automatically aggregated by a formula. To boost students' enthusiasm and participation, a hierarchical system is adopted. When students reach the set scores, they can upgrade (Intern Quality Inspector < Quality Inspector < Assistant Engineer < Quality Engineer < Senior Engineer < Quality Director < Vice General Manager < General Manager...). Clearly, higher contribution values lead to higher levels and lower passing scores in exams.

Each student's contribution value is shown in the power value. The final score is auto - calculated by an Excel formula. The passing grade is the exam score needed for an overall 60. The total score V is derived by rounding the final result after the flexible transformation of the exam score S.

The formula used by Excel to calculate the total score V.

=ROUND(POWER(G2,POWER((1-Settings and Instructions!B$1),

(SIGN(D2)-1)/2*Settings and Instructions!B$2*POWER(ABS(D2), Settings and Instructions!D$2)+(SIGN(D2)+1)/2*Settings and Instructions!B$3*POWER(ABS(D2),Settings and Instructions!D$3)))*(100/POWER(100,POWER((1-Settings and Instructions!B$1), (SIGN(D2)-1)/2*Settings and Instructions!B$2*POWER(ABS(D2), Settings and Instructions!D$2)+(SIGN(D2)+1)/2*Settings and Instructions!B$3*POWER(ABS(D2),Settings and Instructions!D$3)))),0)

Debug and set system parameters in the "Setup and Description" worksheet. As shown in Figure 3, the current development speed is 0.07, with negative conversion coefficient and power both 1, and positive ones 1 and 0.7. Students earn contribution scores from irregular roll - calls, active responses, discussions, and papers. For discipline violations, the score is the lower of "minus 2" and "score halved".

	A	B	C	D
1	Development Speed v	0.07		
2	Conversion Coefficient a1	1	Conversion Power b1	1
3	Conversion Coefficient a2	1	Conversion Power b2	0.75
4				
5				
6	Contribution Value c	10		
7	Conversion Value C	5.623413252		
8				
9	Power P	0.664915712		
10	Coefficient k	4.679167337		
11	Passing Score BS	46.38211708		
12				
13	Score S	80		
14	Transformation Value V	86.21106492		
15	Rounding FV	86		

Fig. 3. Setup and Description.

To boost system fairness, a random - question module can be set up by embedding VBA in Excel or using external programs. Also, the Excel result table can be saved as an htm page and published online for students to access. [6]. As is illustrated in Figure 4.

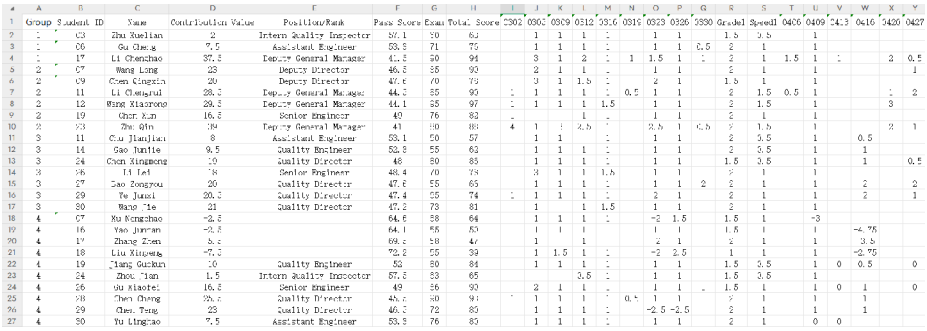

Fig. 4. Student Results Web Page Mode.

5 Conclusion

In the two - year trial, the scoring system improved interaction and atmosphere, and promoted after - class research. Undergraduates finished three papers on relevant topics [6-7] under teachers' guidance. Many students explored, proposed improvements, and voluntarily coded programs like random question modules for the system.

This scoring system comprehensively reflects students' course mastery. Using the contribution value to non - linearly process test scores makes the evaluation more scientific. With computerized processing, grading is simplified. Borrowing from game upgrade modes, it directly shows results on the classroom screen. This enlivens the atmosphere and spurs students' after - class exploration.

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