The Evaluation Index System of Teaching Quality in Colleges and Universities: Based on the CIPP Model

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Received 15 June 2022; Revised 2 July 2022; Accepted 14 July 2022; Published 23 August 2022

Academic Editor: Zaoli Yang

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Under the comprehensive influence of the national political and economic environment, the law of higher education development, and the characteristics of teaching itself, the relationship between theoretical teaching and teaching should be properly handled, and in accordance with the goals and ideas of talent training in research universities, on the one hand, the teaching of theoretical courses should be done well to ensure the protection of students. A solid theoretical foundation, on the one hand, emphasizes the application-oriented and sexual teaching links and forms a teaching system that combines professional skills and professional technical application ability, and comprehensive ability. For research-oriented university education, it is an inevitable problem to face. Just as the diagnosis of a disease is required first, in order to promote teaching reform, it is necessary to have a clear understanding of the current situation of the school teaching system and to understand the root of the problem. Therefore, it is very necessary to study the evaluation of teaching, which will provide facts for the reform. Fundamentals, Orientation, and Metrics. Based on the CIPP model of effective teaching theory and formative assessment theory, this research constructs a teaching quality assurance index system in colleges, universities, and takes colleges and universities as a case for empirical research. The survey on the status quo of quality assurance and the experimental results show that the index system of teaching quality evaluation in colleges and universities based on the CIPP model has good applicability.

1. Introduction

At present, the main way for colleges and universities to carry out teaching activities is still classroom teaching, and evaluating classroom teaching is an important way to test the quality of education and teaching in a school. Classroom teaching evaluation is produced together with classroom teaching. It plays an important role in standardizing all aspects of classroom teaching and is an important means to improve the quality of classroom teaching. In order to realize the requirements of talent training such as knowledge transfer, ability training, and quality improvement, teaching, as an important part of university teaching, began to be given a new mission, and the development of teaching has been promoted to a new stage. Research-oriented college students' teaching evaluation research can promote the teaching evaluation research in the teaching field, enrich the content and level of teaching theory research, and provide new ideas and research methods for the application of education evaluation theory in the field of teaching. The theory of construction and reform has laid a factual foundation. This study focuses on building a teaching evaluation index system to evaluate engineering colleges and universities, in order to measure and improve the teaching quality of engineering colleges and universities. At this stage, because the teaching evaluation indicators of colleges and universities in China are too unified and there is no difference in treatment, classified evaluation can better play the guiding role of evaluation, guide colleges and universities at different levels and different disciplines to develop their own characteristics, and guide the peaceful mentality of all kinds of schools. The acceptance of evaluation is of great significance and should be used as an important reference for the formulation of a new round of evaluation indicators. The integrity of the evaluation system is more conducive to improving the level of teaching work [1–3].
2. Related Work

In the second half of the twentieth century, various types of educational evaluation organizations were gradually formed in European and American countries, and three representative educational evaluation and education quality assurance models have initially formed: the American model, the European model, and the British model. Among them, in the American model, American universities enjoy a high degree of autonomy and mainly rely on various professional academic institutions and groups in the society to conduct educational evaluations, forming a higher education evaluation system by types, majors, and regions. Currently, there are 6 regional professional accreditation agencies (Central, New England, North Central, Northwest, South, and West) recognized by the U.S. Federal Department of Education. Higher Education Foundation, and the Higher Education Quality Assurance Agency in high education serve the reference for the committee’s funding. In the UK, the government mainly indirectly influences the university family through the Higher Education Fund Committee. The evaluation agency is relatively neutral, but the evaluation results can be used as a reference for the committee’s funding. In the UK, the Quality Assurance Agency in high education serves the Higher Education Foundation according to the contract, and evaluates universities every 6 years; the Research Assessment Exercise is responsible for evaluating the scientific research of universities [4–10].

3. Construction of the Evaluation Index System of Teaching Quality in Colleges and Universities

3.1. Basis for the Establishment of Teaching Evaluation Indicators

3.1.1. Basis for the Establishment of Primary Indicators. This research chooses the CIPP model as the evaluation model, including four kinds of evaluations: teaching background evaluation, teaching input evaluation, teaching process evaluation, and teaching achievement evaluation. Teaching background evaluation is the evaluation of needs, problems, advantages, and opportunities in a specific situation; input evaluation is the evaluation of the educational investment programs, programs, or service strategies and their related work plans and implementation budgets; process evaluation is the evaluation of program implementation, process documents, change the major mistakes or bad operations of certain procedures of the plan, and conduct continuous inspection and evaluation; the outcome evaluation is to evaluate the complete performance of the implementation results of the project and the degree to which the needs of all beneficiaries are met. Therefore, the four first-level indicators are teaching background evaluation, teaching input evaluation, teaching process evaluation, and teaching achievement evaluation [11–13].

3.1.2. Basis for the Establishment of Secondary Indicators. This paper deeply studies the theory of higher education evaluation, teaching theory, and teaching evaluation theory at home and abroad, clarifies the connotation, significance, and influencing factors of the first-level indicators above, and selects five second-level indicators for each first-level indicator in a comprehensive and systematic way. The secondary indicators of teaching background evaluation can refer to the main observation points of the “Guiding Ideas for Running Schools” in the teaching level evaluation indicators: positioning and planning, educational ideology, and teaching centrality. Combined with the teaching practice, five secondary indicators are listed: teaching concept, teaching purpose, teaching plan, educational regulations, and social needs. The selection of secondary indicators for the evaluation of teaching investment can be obtained by referring to the theory of production factors in economics. There are four types of production factors in economics, productivity, land, capital, and entrepreneurial talent. Later, information technology gradually became an independent production factor. Elements participate in social production activities. Taking into account the difference between the teaching activities of colleges and universities and the general production activities, five secondary indicators are listed: teachers, bases, funding, laboratories, and teaching materials. The selection of secondary indicators of teaching process evaluation can consider the theory of teaching system elements. At present, there are many theories about the constituent elements of the teaching system in the academic circle. Among them, Mr. Li Bingde explained the seven elements in the article “Review and Prospect of Teaching Theory” in 1989, that teaching activities include seven elements: teacher, student, purpose, content, method, environment, and feedback. Taking this theory into consideration, five secondary indicators are listed: teaching content, teaching methods, curriculum setting, teaching supervision, and teaching assessment. The secondary indicators of teaching achievement evaluation can be derived from the subsequent development of the CIPP theory. After establishing this model, Stafford Beam reconsidered the evaluation and believed that the four-step evaluation model was not enough to describe and evaluate long-term, real success reform plan. To this end, he supplemented and improved it, and decomposed the outcome.
evaluation into four parts: impact, effectiveness, sustainability, and transportability [14–18]. The final indicator system is shown in Table 1 below.

### 3.2. Determination of Teaching Evaluation Index System

The index system of teaching evaluation in research-oriented universities is based on CIPP, as shown in Table 2.

### 3.3. Determination of Evaluation Index System

This study adopts the Delphi method, consulted five professors and experts engaged in higher education teaching and university management, analyzed the returned three-point consultation questionnaire to obtain a scientific and reasonable indicator weight judgment result, and then use the analytic hierarchy process to calculate. For the weights of indicators at all levels, the final weight results are as follows: according to the above calculation results, three decimal places are reserved, and the weight distribution of indicators is as follows: [19, 20].

\[
\begin{align*}
A_w &= [0.095, 0.183, 0.355, 0.367], \\
B1_w &= [0.122, 0.230, 0.648], \\
B2_w &= [0.539, 0.164, 0.297], \\
B3_w &= [0.230, 0.648, 0.122], \\
B4_w &= [0.539, 0.164, 0.297].
\end{align*}
\]

The established teaching evaluation framework is shown in Figure 1 below.

### 4. Application of Teaching Quality Evaluation in Colleges and Universities Based on CIPP Model

#### 4.1. Data Collection and Organization

All the scores of the questionnaire were entered and counted with Excel software, and all the questionnaires with the same score for a single index were excluded, and the total score of each questionnaire was calculated based on the weights of the indicators at all levels, and the comprehensive evaluation result was obtained. The calculation method is:

\[
\begin{align*}
VB1 &= 0.112 \times C1 + 0.230 \times C2 + 0.648 \times C3, \\
VB2 &= 0.539 \times C4 + 0.164 \times C5 + 0.297 \times C6, \\
VB3 &= 0.230 \times C7 + 0.648 \times C8 + 0.122 \times C9, \\
VB4 &= 0.539 \times C10 + 0.164 \times C11 + 0.297 \times C12, \\
VA &= 0.095 \times VB1 + 0.183 \times VB2 + 0.355 \times VB3 + 0.367 \times VB4. 
\end{align*}
\]

#### 4.2. University Teaching Evaluation Data Analysis

In order to judge the influence relationship between teaching background, teaching input, teaching process and teaching results, and analyze the relationship between teaching background, teaching input and teaching process, on the basis of the above basic statistics and comparative analysis, regression analysis was performed on engineering, liberal arts, and total data, and the process was as follows:

4.2.1. Correlation Analysis of the First-Level Indicators of Science Teaching

Taking the teaching achievement as the dependent variable \(Y\), and the teaching background, teaching input, and teaching process as the independent variables, input the statistical results of science data columns \(B1, B2, B3,\) and \(B4\) into the EXCEL data analysis interface, select regression analysis, and output the following results.

According to the results shown in Tables 3–5, the binary linear regression equation of science teaching results can be directly written:

\[Y = b0 + b1 \times X1 + b2 \times X2 + b3 \times X3 = 0.953 + 0.379 \times 1 + 0.309 \times 2 + 0.174 \times 3.\]

\(b1\) means that when the teaching investment and teaching process scores are determined, for each additional point of teaching background, the teaching results increase by 0.379 points; \(b2\) means that when the teaching background and teaching input scores are determined, each additional point in the teaching process will increase the teaching results by 0.379 points. The correlation coefficient of regression statistics is 0.768539, indicating that when the three variables change, the degree of correlation between the dependent variable and the independent variable is 0.768539, indicating that the multiple correlation coefficient of the three variables of teaching background, teaching investment, and teaching process is 0.768539. The coefficient of determination is equal to 59.06% for the goodness of fit, indicating that 59.06% of the changes in the evaluation of teaching results can be explained by the changes in the three factors of teaching background, teaching input, and teaching process, and the remaining factors are random errors. Generally speaking, a goodness of fit greater than or equal to 0.6 is considered acceptable, and greater than 0.8 is considered excellent. In this analysis, the goodness of fit is approximately 0.6, which is acceptable. Given the significance level \(a = 0.05\), \(F = 11.062\) can be obtained by looking up the table, which is greater than \(F(0.05(2,25)) = 3.39\), so the null hypothesis is rejected, indicating that the \(R^2\) of the sample is significant, and the established multiple linear regression model is valid. Because the overall relationship of the equation is significantly different from that each independent variable has a significant effect on the dependent variable, a significant \(t\)-test is also performed for each independent variable. Given the significance level \(a = 0.05\), look up the table to get \(t(0.05/2(27-3)) = 2.064\), the test statistic of \(b1\) \(t1 = 2.219523 > 2.064\), reject the hypothesis of \(H0:b1 = 0;\) the test statistic of \(b2\) quantity \(t2 = 1.464698 < 2.064\), the hypothesis of \(H0:b2 = 0\) is not rejected; the test statistic of \(b3\) \(t3 = 0.89623 < 2.064\), the hypothesis of \(H0:b3 = 0\) is not rejected. Therefore, only the regression coefficient \(b1\) is statistically significant, and in the correlation analysis of the science data, only the teaching background has a significant impact on the teaching results [21].

4.2.2. Correlation Analysis of the First-Level Indicators of Engineering Teaching

Taking the teaching achievement as the dependent variable \(Y\), and the teaching background, teaching investment, and teaching process as the
independent variables, input the engineering data statistical results $B_1$, $B_2$, $B_3$, and $B_4$ into the Excel data analysis interface, select regression analysis and output the following results.

According to the results shown in Tables 6–8, the binary linear regression equation of engineering teaching results can be directly written: $Y = b_0 + b_1 \times X_1 + b_2 \times X_2 + b_3 \times X_3 = -1.280 + 0.364 \times 1 + 0.390 \times 2 + 0.408 \times 3$. $B_1$ means that when the teaching investment and teaching process scores are determined, for each additional point of teaching background, the teaching results increase by 0.364 points; $b_2$ means that when the teaching background and teaching process scores are determined, for each additional point in the teaching process, the teaching results will increase by 0.390 points; $b_3$ means that when the teaching background and teaching investment scores are determined, for each additional point in the teaching process, the teaching results will increase by 0.408 points.

| First-level indicator     | Secondary indicators                                                                 |
|---------------------------|--------------------------------------------------------------------------------------|
| Teaching background        | Teaching concept, teaching purpose, teaching plan                                    |
| Teaching investment        | Faculty, base and equipment stock, and funding                                      |
| Teaching process           | Teaching content, teaching methods, teaching supervision, and assessment             |
| Teaching achievement       | Student ability, reform and innovation, and social recognition                      |

**Table 2: Index system of teaching evaluation in research-oriented universities based on CIPP model.**

| First-level indicator | Secondary indicators                                                                 |
|-----------------------|--------------------------------------------------------------------------------------|
| Teaching background   | Teaching concept C1, Teaching purpose C2, Teaching plan C3                           |
|                       | Faculty C4, Base and equipment inventory C5, Funding input C6                        |
|                       | Teaching concept science, advanced level, The purpose of teaching is clear and in-depth, The teaching plan is clear and reasonable |
| Teaching input        | Teaching content C7, Teaching methods C8, Teaching supervision and assessment C9    |
|                       | Abundance of base equipment stock, The strength of teaching faculty                  |
| Teaching process       | Rich and practical teaching content, Teaching method science, flexibility           |
|                       | Teaching supervision and careful assessment of the seriousness                       |
| Teaching outcomes      | Student ability C10, Reform and innovation C11, Social recognition C12              |
|                       | Students with strong ability and comprehensive quality, Faster reform and innovation of teaching, High degree of social recognition of students and institutions |

**Table 3: Correlation analysis table of first-level indicators of science teaching (1).**

| Regression statistics    | 0.768539 |
|--------------------------|----------|
| Multiple R               | 0.768539 |
| R square                 | 0.590652 |
| Adjusted R square        | 0.537258 |
| Standard error           | 1.103188 |
| Observations             | 27       |

According to the results shown in Tables 6–8, the binary linear regression equation of engineering teaching results can be directly written: $Y = b_0 + b_1 \times X_1 + b_2 \times X_2 + b_3 \times X_3 = -1.280 + 0.364 \times 1 + 0.390 \times 2 + 0.408 \times 3$. $B_1$ means that when the teaching investment and teaching process scores are determined, for each additional point of teaching background, the teaching results increase by 0.364 points; $b_2$ means that when the teaching background and teaching process scores are determined, for each additional point in the teaching process, the teaching results increase by 0.390 points; $b_3$ means that when the teaching background and teaching investment scores are determined, for each additional point in the teaching process, the teaching results will increase by 0.408 points.
increase by 0.408 points. The correlation coefficient of regression statistics is 0.8903, indicating that when the three variables change, the degree of correlation between the dependent variable and the independent variable is 0.8903, indicating that the multiple correlation coefficient of the three variables of teaching background, teaching investment and teaching process is 0.8903. The coefficient of determination is equal to 79.27% for the goodness of fit, indicating that 79.27% of the changes in the evaluation of teaching results can be explained by the changes in the three factors of teaching background, teaching input, and teaching process, and the remaining factors are random errors. The goodness of fit in this analysis is approximately 0.8, which is an excellent level. Given the significance level $a = 0.05$, $F = 40.798$ can be obtained by looking up the table, which is greater than $F_{0.05}(2, 33) = 3.28$, so the null hypothesis is rejected, indicating that...
4.2.3. Correlation Analysis of the First-Level Indicators of Liberal Arts Teaching. Taking the teaching achievement as the dependent variable $Y$, and the teaching background, teaching input, and teaching process as the independent variables, input the liberal arts data statistical results columns $B1$, $B2$, $B3$, and $B4$ into the EXCEL data analysis interface, select regression analysis, and output the following results.

According to the results shown in Tables 9–11 above, the binary linear regression equation of liberal arts teaching results can be directly written: $Y = b0 + b1 \times X1 + b2 \times X2 + b3 \times X3 = 2.019 + 0.145 \times 1 + 0.153 \times 2 + 0.490 \times 3$. $B1$ means that when the teaching investment and teaching process scores are determined, for each additional point of teaching background, the teaching results increase by 0.145 points; $b2$ means that when the teaching background and teaching process scores are determined, for each additional point of teaching investment, the teaching results increase by 0.153 points; $b3$ means that when the teaching background and teaching investment scores are determined, each additional point in the teaching process will increase the teaching results by 0.490 points. The correlation coefficient of regression statistics is 0.8031, indicating that when the three variables change, the degree of correlation between the dependent variable and the independent variable is 0.8031, indicating that the multiple correlation coefficient of the three variables of teaching background, teaching investment and teaching process is 0.8031. The coefficient of determination is equal to 64.49% and the goodness of fit is equal to 64.49%, indicating that 64.49% of the changes in the evaluation of teaching results can be explained by the changes in the three factors of teaching background, teaching investment, and teaching process, and the remaining factors are random errors. The goodness of fit in this analysis is 0.645, which is acceptable. Given the significance level $a = 0.05$, $F = 22.405$ can be obtained by looking up the table, which is greater than $F0.05(2, 38) = 3.24$, so the null hypothesis is rejected, indicating that the $R^2$ of the sample is significant, and the established multiple linear regression model is valid. Because the overall relationship of the equation is significantly different from that each independent variable has a significant effect on the dependent variable, a significant $t$-test is also performed for each independent variable. Given the significance level $a = 0.05$, look up the table to get $t_{0.05/2(36-3)} = 2.035$, the test statistic of $b1$ $t1 = 2.390 > 2.035$, reject the hypothesis of $H0: \beta1 = 0$; the test statistic of $b2$ The quantity $t2 = 2.553 > 2.035$, reject the hypothesis of $H0: \beta2 = 0$; the test statistic of $b3$ is $2.778 > 2.035$, reject the hypothesis of $H0: \beta3 = 0$. Therefore, the regression coefficients $b1$, $b2$, and $b3$ are statistically significant. In the correlation analysis of engineering data, the effects of teaching background, teaching investment, and teaching process on teaching results are all significant.

4.2.4. Correlation Analysis of First-Level Indicators of Teaching in Research Universities. Taking the teaching achievement as the dependent variable $Y$, and the teaching background, teaching input, and teaching process as the independent variables, input the columns $B1$, $B2$, $B3$, and $B4$ of all the statistical results of the data into the EXCEL data analysis interface, select regression analysis, and output the following results.

According to the results shown in Tables 12–14 above, the binary linear regression equation of the teaching achievement of research universities can be directly written:
does not reject the hypothesis of $H_0$: $\beta_1 = \beta_2 = \beta_3 = 0$. The test statistic of $t_1 = 4.740 > 1.984$, rejects the hypothesis of $H_0$: $\beta_1 = 0$; the test statistic of $t_2 = 1.722 < 1.984$, does not reject the hypothesis of $H_0$: $\beta_2 = 0$; the test statistic of $t_3 = 4.033 > 1.984$, rejects the hypothesis of $H_0$: $\beta_3 = 0$. Therefore, the regression coefficients $b_1$ and $b_3$ are statistically significant, that is, in the correlation analysis of research university data, the influence of teaching background and teaching process on teaching results is significant. The data statistics and related analysis results of this chapter are summarized in the following Table 15:

### 5. Conclusion

On the basis of fully consulting teaching experts, this research selects 12 secondary indicators, uses the expert consultation method to collect experts’ judgment of the importance of the indicators, and uses the analytic hierarchy process to finally determine the indicator system. Then, this research uses this index system to study the teaching evaluation of research universities in Guangdong Province, describes the current research university teaching status, points out the problems existing in the current research university teaching, and analyzes the current situation of research university teaching on the basis of statistics and analysis data. The reasons for the current problems in the teaching of research universities. The whole research adheres to the principle of objectivity and authenticity. The CIPP model used in this study is an analysis model suitable for the research situation. The problem analysis and countermeasure suggestions are completely based on real data, and the results are authentic and credible. Due to the limitation of the professional quality of researchers and the number of consultants, the evaluation indicators proposed in this paper may not be all reasonable and will be used as a scope for further improvement in the future.

### Data Availability

The dataset can be accessed upon request.

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**Table 14: Correlation analysis table of first-level indicators of teaching in research universities (3).**

| Indicator | Coefficient | Standard Error | t-Value | P-Value | Lower 95% | Upper 95% | Lower Limit 95.0% | Upper Limit 95.0% |
|-----------|-------------|----------------|---------|---------|-----------|-----------|-------------------|-------------------|
| Intercept | 0.65002     | 0.46502        | 1.39783 | 0.16525 | -0.2725   | 1.57262   | -0.2725           | 1.57262           |
| X variable 1 | 0.39962 | 0.08430 | 4.74004 | 7.09 $E$ | 0.23236   | 0.56689   | 0.23236           | 0.56689           |
| X variable 2 | 0.13876 | 0.08054 | 1.72277 | 0.08802 | -0.0210   | 0.29857   | -0.0210           | 0.29857           |
| X variable 3 | 0.38909 | 0.09645 | 4.0387 | 0.00010 | 0.19772   | 0.58046   | 0.19772           | 0.58046           |

**Table 15: Research-oriented teaching evaluation data analysis summary.**

| Indicator | Teaching background | Teaching input | Teaching process | Teaching achievements | Teaching evaluation |
|-----------|---------------------|----------------|-----------------|----------------------|---------------------|
| Science   | 7.293 (significant impact on teaching results) | 7.388 | 6.809 | 7.193 | 7.102 |
| Engineering | 6.663 (significant impact on teaching results) | 6.841 (significant impact on teaching outcomes) | 6.252 (significant impact on teaching results) | 6.378 | 6.445 |
| Liberal arts | 6.907 | 5.783 | 6.037 (significant impact on teaching results) | 6.870 | 6.379 |
| Research university | 6.922 (significant impact on teaching results) | 6.566 | 6.312 (significant impact on teaching outcomes) | 6.784 | 6.590 |

Remarks: Correlation analysis (regression) goodness of fit is greater than 0.6. The correlation coefficient of regression statistics is 0.806, indicating that when teaching investment and teaching process scores are determined, for every one-point increase in teaching background, teaching results increase by 0.399 points; $b_2$ means when teaching background and teaching process scores are determined, for every one-point increase in teaching investment, teaching results increase by 0.138 points; $b_3$ means when the teaching background and teaching investment scores are determined, for each additional point in the teaching process, the teaching results will increase by 0.389 points. The correlation coefficient of regression statistics is 0.806, indicating that when the three variables change, the degree of correlation between the dependent variable and the independent variable is 0.806, indicating that the multiple correlation coefficient of the three variables of teaching background, teaching investment, and teaching process is 0.806. The coefficient of determination is equal to 65.0% for the goodness of fit, indicating that 65.0% of the changes in the evaluation of teaching results can be explained by changes in the three factors of teaching background, teaching investment, and teaching process, and the remaining factors are random errors. The goodness of fit in this analysis is 0.65, which is acceptable. Given the significance level $a = 0.05$, $F = 61.9212$ can be obtained by looking up the table, which is greater than $F_{0.05}(2, 102) = 3.09$, so the null hypothesis is rejected, indicating that the $R^2$ of the sample is significant, and the established multiple linear regression model is valid. Because the overall relationship of the equation is significantly different from that each independent variable has a significant effect on the dependent variable, a significant $t$-test is also performed for each independent variable. Given the significance level $a = 0.05$, look up the table to get $t_{0.05/2(105-3)} = 1.984$, the test statistic of $b_1$ $t_1 = 4.740 > 1.984$, reject the hypothesis of $H_0$: $\beta_1 = 0$; the test statistic of $b_2$ $t_2 = 1.722 < 1.984$, does not reject the hypothesis of $H_0$: $\beta_2 = 0$; the test statistic of $b_3$ is $4.033 > 1.984$, rejects the hypothesis of $H_0$: $\beta_3 = 0$. Therefore, the regression coefficients $b_1$ and $b_3$ are statistically significant, that is, in the correlation analysis of research university data, the influence of teaching background and teaching process on teaching results is significant. The data statistics and related analysis results of this chapter are summarized in the following Table 15.
Conflicts of Interest

The authors declare that they have no conflicts of interest.

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