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Teaching Evaluation System on Engineering for Applied University in China

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Abstract: This research presents a novel Teaching Evaluation System model designed to enhance the quality of education in Chinese applied universities with a focus on engineering programs. The objectives included synthesizing relevant theories related to teaching evaluation systems in applied university engineering and developing a comprehensive system. A population of 9 experts from China was selected through purposive sampling, all qualified and with a minimum of five years' experience as Assistant Professors at the same university. SPSSPRO was employed for data assessment, ensuring questionnaire reliability with a Cronbach's α of .823, indicating excellent reliability. The research result, with an average score of 4.6358, SD. = 0.4655, CV = .1008, IQR = 1, demonstrated a strong agreement among expert opinions. Utilizing the Analytic Hierarchy Process (AHP) for weighting analysis and assessing matrix consistency, CR = .039 < .1, suggested sufficient consistency for decision-making. The research employed focus groups to discuss the evaluation system for Chinese applied university engineering education, utilizing the CIPP model, modifying the evaluation index system, and employing AHP for indicator ranking. A case study at Sichuan University of Science & Engineering, using the new evaluation index system, revealed program issues, and offered recommendations. The index system comprises four first-level, 12 second-level, and 52 third-level indexes, providing a reflective evaluation of the actual relationships among indicators and serving as a valuable reference for assessing engineering education quality.

Keywords: Teaching Evaluation, Engineering, Focus Group, CIPP, Applied University.

1. Introduction

Engineering education stands as a crucial pillar in China's economic and technological progress, necessitating a strong focus on the quality of teaching in engineering programs. This paper introduces a Teaching Evaluation System designed for assessing the teaching effectiveness of engineering courses in Chinese applied universities. The system aims to support faculty development, enhance student learning outcomes, and continually improve teaching methodologies. In 2020, the CPC and State Council released a plan for educational evaluation reform, emphasizing the importance of audits and evaluations in ensuring higher education quality and development. The institutionalization of a higher education quality assurance system is imperative.

International higher education and talent training heavily rely on evaluation to ensure quality. Developed nations such as the US, UK, France, Germany, Japan, and South Korea actively use evaluation to enhance higher education and teaching. They employ legal and regulatory systems for quality assurance, assessing various aspects such as course quality, professional certification, college evaluation, teaching evaluation, and scientific research. China's teaching evaluation in higher education has evolved, adopting modern principles with extensive coverage and operational flexibility.

Chinese universities prioritize engineering specialty evaluation indexes, considering factors such as teaching quality, course content, faculty qualifications, student performance, facilities, research, innovation, student feedback, satisfaction, and employment prospects. However, differing standards and weights across universities and educational institutions pose a challenge.

To maintain academic excellence and produce competitive engineering graduates, Chinese universities have stringent teaching evaluation systems. Applied universities, specifically, provide practical education to prepare students for the dynamic engineering landscape. China's Teaching Evaluation System for Engineering in Applied Universities focuses on adaptability to industry needs and stakeholder expectations. It assesses teaching methods, curriculum design, faculty qualifications, research contributions, and infrastructure support for continual improvement.

This system emphasizes hands-on learning and real-world projects in engineering, aiming to deepen knowledge and foster creativity and problem-solving skills. It encourages contributions from all stakeholders, including students who provide valuable input during evaluations. Professional development for faculty ensures they stay current with technological advancements and industry demands. The system now incorporates multidisciplinary courses, recognizing the changing landscape of engineering fields.

The paper concludes by examining China's Engineering Teaching Evaluation System for Applied Universities, assessing its components, criteria, and impacts on engineering education. Understanding its strengths and weaknesses provides insights into applied universities' efforts to enhance engineering education and contribute to China's engineering sector (Khoo et al., 2020; Sangsawang et al., 2011).

2. Literature Review

2.1 Quality Assurance Systems

Quality assurance systems in higher education have increasingly focused on the quality of undergraduate education, necessitating a comprehensive examination of students (Lin & Geng, 2019; Sangsawang et al., 2006a). The prolonged and resource-intensive process of completing undergraduate education significantly influences the quality of future master's and doctoral programs (Ministry of Education of the People's Republic of China, 2021). In China, the Teaching and Learning Evaluation Center of the Ministry of Education has initiated various assessment initiatives since 2013, including the report on the quality of undergraduate teaching in colleges and universities (Ministry of Education of the People's Republic of China, 2020). These initiatives aim to enhance the quality of engineering talent cultivation in China (Zhao et al., 2020).

It is evident that undergraduate education places considerable emphasis on evaluating university majors and undergraduate programs (Hongyu & Zhida, 2009; Luaensutthi & Sangsawang, 2023; Sangsawang et al., 2006b). In recent years, professional evaluation has gained independence from educational evaluation, playing a crucial role in assessing higher education institutions, while educational evaluation continues to encompass higher education (Sangsawang, 2020; Yao et al., 2022).

At present, the uniformity of teaching evaluation indicators in Chinese colleges and universities hampers differentiated treatment. Classified evaluation, which guides institutions at different levels and disciplines to develop their characteristics, is essential for promoting a peaceful mentality among various schools. The acceptance of evaluation is significant and should serve as a crucial reference for formulating a new round of evaluation indicators. An integrated evaluation system is more conducive to enhancing teaching work (Li & Hu, 2022; Sangsawang, 2015).

While studies on evaluation systems have been conducted in certain fields in China, such as architecture and engineering cost, more professional guidance is needed to address issues like imperfect evaluation systems and indicators, ensuring strong operability for effective professional protection. Although China's higher education policy has shifted focus from macro to micro levels, the corresponding evaluation system must catch up. The evaluation of student competence at the undergraduate level has become a weak link in the higher education evaluation system (Sangsawang et al., 2007; Wang, 2020).

This paper, based on the CIPP model, constructs a teaching evaluation system for engineering at applied universities in China. The system was applied to engineering courses at Sichuan University of Science & Engineering to verify feasibility and operability. The results offer guidance and assistance for improving engineering courses at the university, along with proposed improvement strategies to address identified issues in the teaching process.

2.2 Teaching Evaluation Criteria

The Teaching Evaluation System is constructed based on well-defined criteria that encompass essential aspects of effective engineering education, such as course design, instructional delivery, student engagement, assessment methods, and faculty-student interactions. These criteria serve as guiding principles when assessing the quality of teaching. In China, where engineering education plays a crucial role in technological and economic progress, applied universities are instrumental in offering specialized engineering education. The evaluation systems implemented by these universities for teaching are pivotal in upholding and improving the overall quality of education.

This literature review delves into existing research and literature on the Teaching Evaluation System of Engineering for Applied Universities in China. By analyzing prior studies, the objective is to gain insights into the system's strengths, challenges, and overall effectiveness in nurturing competent engineers for the nation.

2.2.1 Teaching Evaluation Frameworks in China

Research emphasizes the significance of effective teaching evaluation frameworks to uphold educational quality and relevance. Studies have scrutinized the various components of the Teaching Evaluation System for engineering programs in applied universities. These components cover teaching quality, course content and structure, faculty qualifications and development, student performance and learning outcomes, facilities and infrastructure, research and innovation, student feedback, and employment prospects.

2.2.2 Balancing Theoretical and Practical Learning

The literature underscores the vital role of applied universities in bridging the gap between theoretical knowledge and practical skills. The Teaching Evaluation System advocates for the integration of hands-on experiences and real-world projects into engineering curricula. Researchers have explored the impact of practical learning approaches on students' problem-solving abilities, critical thinking, and industry readiness.

2.2.3 Student-Centered Evaluation

Studies highlight the importance of incorporating student feedback into the teaching evaluation process. Students' perspectives are considered valuable for assessing teaching effectiveness and identifying areas for improvement. Research has examined methods of collecting student feedback, including surveys and focus groups, and how these perspectives contribute to faculty development and curriculum enhancement.

2.2.4 Faculty Development and Qualifications

The Teaching Evaluation System places strong emphasis on faculty qualifications and professional development. Scholars have investigated the correlation between faculty expertise, research output, and teaching effectiveness. Additionally, the impact of faculty development programs on improving instructional methods and fostering a supportive learning environment has been explored.

2.2.5 Challenges in Engineering Education Evaluation

Despite the strengths of the Teaching Evaluation System, challenges persist. Studies have addressed potential issues related to faculty workload, standardized evaluation methods across institutions, and the inclusion of interdisciplinary and emerging engineering fields in the evaluation process. Researchers have proposed strategies to overcome these challenges and ensure continuous improvement of the system.

2.2.6 Impact on Engineering Education

The literature provides insights into the impact of the Teaching Evaluation System on the overall quality of engineering education in applied universities. Studies have assessed the system's effectiveness in producing competent engineering graduates who meet the demands of the job market. Furthermore, research has explored the system's role in aligning engineering education with industry needs and fostering innovation and research contributions.

The Teaching Evaluation System on Engineering for Applied Universities in China serves as a critical mechanism to enhance the quality of engineering education and nurture skilled engineers. The comprehensive nature of the evaluation system, with its focus on practical learning, faculty development, and student feedback, is highlighted in the literature review. While acknowledging challenges, the review offers suggestions for continuous improvement. Through a deeper understanding of existing research, stakeholders can gain valuable insights to further strengthen engineering education in applied universities and contribute to the country's technological advancement.

2.3 Focus Group

Focus groups are small, monitored groups designed to answer tailored questions, with participants chosen based on demographics. In qualitative research, these groups provide insights through interactions, responses, and nonverbal cues, guiding investigations into consumer behavior, products, services, or contentious topics (Stevenson, 2010). When evaluating a program, focus groups offer natural and detailed feedback, surpassing one-on-one interviews in simplicity and coordination (Stewart & Shamdasani, 2014). They involve group interviews with individuals sharing similar backgrounds or experiences, allowing researchers to analyze responses and gather qualitative data. Interactive focus groups, commonly facilitated discussions, serve as effective tools for research and evaluation (Krueger, 2014). Various disciplines, including communication, education, political science, and public health, employ focus groups as a method (Morgan, 1996). Qualitative research in focus groups involves open conversations, utilizing group interaction to elucidate participants' beliefs, opinions, and viewpoints (Kitzinger, 1995). The facilitator takes notes or recordings, and careful participant selection ensures usable data. Observers may note nonverbal dynamics, enhancing the understanding of group dynamics.

2.4 Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP), developed by Thomas L. Saaty, is a decision-making methodology for solving complex problems with multiple criteria and alternatives. It breaks down problems into a hierarchical structure and involves pairwise comparisons at each level, expressing relative importance on a scale. After checking for consistency, mathematical calculations determine the weights of criteria and alternatives (Leal, 2020). AHP synthesizes results to rank alternatives based on overall desirability, serving as a versatile tool in various contexts to make informed and objective decisions amidst conflicting criteria and limited resources (Chan et al., 2019).

2.5 CIPP Model

The CIPP evaluation model, developed by Daniel Stufflebeam and colleagues in the 1960s, is a program evaluation framework (Stufflebeam et al., 2000). This program assessment paradigm, known as CIPP, stands for Context, Input, Process, and Product. CIPP evaluates program value by systematically assessing these four components. The decision-focused CIPP evaluation emphasizes providing systematic program management and operational information (Finney, 2020). This framework establishes a connection between assessment and program decision-making, offering an analytical and rational basis for decision-making through a planning, structuring, implementing, reviewing, and changing cycle, each analyzed through a specific evaluation aspect—context, input, process, and product assessment (Stufflebeam & Zhang, 2017). The CIPP methodology ensures that assessment remains relevant to decision-makers throughout program phases and activities. Stufflebeam's CIPP evaluation model, encompassing context, input, process, and product, is recommended to systematically guide the conception, design, implementation, and assessment of service-learning projects, providing valuable feedback and judgment for continuous improvement (Lee et al., 2019).

3. Methods

The research design for studying the Teaching Evaluation System on Engineering for Applied Universities in China should be comprehensive and multi-faceted. To fully assess the Teaching Evaluation System's impact on Applied Engineering programs, a mix of quantitative and qualitative research methods will triangulate data to validate findings in China.

3.1 Data Collection Method

Step 1: Surveys - Conducting surveys among faculty members and administrators is crucial to gather quantitative data on their perceptions of the Teaching Evaluation System. The survey questionnaire should cover aspects such as teaching quality, course content, faculty qualifications, and infrastructure support. Additionally, document analysis, involving the examination of official documents, policy guidelines, and reports on the Teaching Evaluation System, can offer a deeper understanding of its structure, criteria, and implementation strategies. This analysis will also help identify any changes or updates made to the system over time.

Step 2: Interviews - Conduct semi-structured interviews with nine experts located in China, chosen through purposive sampling. Each expert should hold a doctoral degree and have at least five years of experience, preferably as Assistant Professors. Utilize the focus group method in three rounds of discussions to develop a teaching evaluation system on engineering for applied universities in China.

Step 3: Analytic Hierarchy Process - Employ the Analytic Hierarchy Process (AHP) to establish the weights of the teaching evaluation system on engineering for applied universities in China. Create a hierarchical model of the teaching evaluation system index and construct pairwise comparison judgment matrices. Invite experts to compare and score the importance of the indexes. Carry out normalization calculations and consistency tests on the scoring data. After passing the consistency test, obtain the final weights of all levels of the teaching evaluation system index.

Step 4: Case Analysis - Apply the CIPP model-based teaching evaluation system on engineering for applied universities in China to Sichuan University of Science & Engineering. Observe, record, analyze, summarize, and reflect on the teaching background, input, process, and results. Propose corresponding solutions to further optimize and improve the teaching evaluation system on engineering for applied universities in China.

To ensure representative research findings, employ a diverse and purposive sampling strategy, including students from various engineering disciplines, faculty members with different experience levels, and administrators responsible for curriculum development and evaluation.

3.2 Data Analysis

The Teaching Evaluation System study is clear, rigorous, and adaptive to China's engineering education demands. The findings could provide guidance to educational policymakers, university administrators, and faculty regarding the system's strengths and weaknesses in improving engineering education in applied universities.

a) Quantitative Analysis: Statistical software can generate descriptive statistics, such as mean, standard deviation, and frequency distribution, from survey data. T-tests and ANOVA can be employed to identify perceptual differences among groups.

b) Qualitative Analysis: The interviews can be transcribed and analyzed to identify themes and patterns related to the Teaching Evaluation System. Response coding and categorization assist in drawing meaningful conclusions.

4. Findings

Teaching performance undergoes evaluation through student evaluations, peer reviews, and classroom observations. Chinese engineering educators, following the

EdPEx questionnaire-based focus group process, undergo assessment focusing on strategic planning, effective instruction, and professional development with feedback from students and industry professionals. EdPEx contributes to the cultivation of ethical and responsible engineers through the following mechanisms:

1) Student Evaluations: These evaluations play a crucial role in the Teaching Evaluation System, gathering feedback on various aspects, including clarity of instruction, faculty approachability, and overall learning experience. Anonymous surveys ensure candid responses.
2) Peer Reviews and Self-Assessment: Peer reviews involve faculty observing and evaluating each other's teaching practices. Self-assessment allows instructors to reflect on their methods and identify areas for improvement, fostering a culture of constructive feedback and collaboration.
3) Classroom Observations: Qualified observers provide valuable insights into teaching dynamics, focusing on instructional strategies, classroom management, and student engagement.
4) Feedback Mechanisms: The Teaching Evaluation System includes well-defined feedback mechanisms, ensuring effective communication of evaluation results to faculty members. Individual feedback sessions, workshops, and review meetings facilitate constructive discussions and action plans.
5) Integration of Evaluation Results: Beyond assessing teaching performance, the system integrates results into faculty development plans, curriculum enhancements, and institutional decision-making processes, influencing teaching strategies and continuous improvement.
6) Faculty Development: An integral part of the system, faculty development aims to enhance teaching skills, knowledge of innovative pedagogies, and familiarity with emerging technologies through workshops, training sessions, and mentoring programs.

Regarding the research methodology, the study utilized a Focus Group technique with a mix of quantitative, qualitative, and analytic hierarchy process methods. The research instruments, data collection procedures, and statistical methods were comprehensively explained. The participants, consisting of 9 experts from China selected through purposive sampling, were qualified evaluators with a minimum of five years' experience as Assistant Professors. The saturation criterion determined the number of interviewees, and Sichuan University of Science & Engineering was selected as the participant.

The research tools included semi-structured interviews (Magaldi & Berler, 2020) for brainstorming, Questionnaire I for evaluating items based on the CIPP model, Questionnaire II for refining responses, Questionnaire III for finalizing the teaching evaluation system, and the Analytic Hierarchy Process for weighting analysis. The judgment matrix construction involved pairwise comparisons and scoring by the experts, ensuring a comprehensive assessment of the Teaching Evaluation System on Engineering for Applied Universities in China.

Table 1. Analysis Results of Teaching Background

Third-Level Index	M	Opinion of Experts	SD	CV%	IQR	Consensus
C1.Construction of quality standards for engineering talents training	4.56	Strongly agree	.53	11.57	1	Congruence
C2.Development orientation of engineering talents	4.67	Strongly agree	.50	10.71	1	Congruence
C3.Talent training reflects the characteristics of running a school	4.44	Moderately agree	.53	11.86	1	Congruence
C4.Synchronization of professional construction and industry development	4.56	Strongly agree	.53	11.57	1	Congruence
C5.Accuracy of course teaching objectives	4.78	Strongly agree	.44	9.23	1	Congruence
C6.Matching degree between course teaching objectives and students' career development	4.78	Strongly agree	.44	9.23	1	Congruence
C7.The degree of fit between the teaching objectives of the course and the formation of students' theoretical knowledge and practical ability	4.67	Strongly agree	.50	10.71	1	Congruence

From Table 1, the analysis results indicate that the opinions of the 9 experts strongly agreed, with a mean score of 4.67, a standard deviation (SD) of .47, and an interquartile range (IQR) of 1. The consensus among the experts was congruence.

The mean scores, ranging from 4.44 to 4.78, suggest a high level of agreement or positive assessment across all aspects. The prevalence of "Strongly agree" responses indicates a substantial consensus among the experts. Smaller standard deviation values (.44 to .53) imply that the responses are closely clustered around the mean, indicating a high level of agreement.

The table demonstrates that experts strongly agree on various aspects related to engineering talent training, reflecting a significant consensus in their opinions. The data reveals a positive assessment of these aspects, with minimal variation among expert responses. This information can be valuable for decision-making and enhancing the quality of engineering education.

Table 2. Analysis Results of Teaching Input

Third-Level Index	M	Opinion of Experts	SD	CV%	IQR	Consensus
C8.Investment in teaching funds	4.89	Strongly agree	.33	6.82	1	Congruence
C9.Input and use of teaching equipment	4.67	Strongly agree	.50	10.71	1	Congruence
C10.Construction and utilization of training room	4.89	Strongly agree	.33	6.82	1	Congruence
C11.Construction of applied teaching materials	4.78	Strongly agree	.44	9.23	1	Congruence
C12.Construction and sharing of high-quality teaching resources	4.89	Strongly agree	.33	6.82	1	Congruence
C13.Real project case resource sharing of industrial enterprises	4.78	Strongly agree	.44	9.23	1	Congruence
C14.School-enterprise cooperation	4.78	Strongly agree	.44	9.23	1	Congruence
C15.Teachers' professional titles	4.56	Strongly agree	.53	11.57	1	Congruence
C16.Teacher education	4.67	Strongly agree	.50	10.71	1	Congruence
C17.The proportion of teachers with more than half a year's attachment experience in enterprises	4.78	Strongly agree	.44	9.23	1	Congruence
C18.Proportion of full-time and part-time teachers	4.67	Strongly agree	.50	10.71	1	Congruence
C19.Teacher training opportunities	4.78	Strongly agree	.44	9.23	1	Congruence

From Table 2, the report's result indicates that 9 experts strongly agreed with a mean score of 4.69, SD = 0.44, CV = 9.48%, IQR = 1, and the consensus of experts was congruence. The table illustrates strong agreement among experts for each listed criterion. The relatively low standard deviation values suggest minimal variation in expert opinions for each criterion. The data indicates that experts strongly agree on various aspects related to teaching input, showing a high level of consensus among them. While the standard deviation is low, the coefficient of variation is relatively high, indicating a moderate level of relative variability. The interquartile range suggests that data points are closely clustered around the mean. This analysis provides insights into the effectiveness and consensus among experts regarding teaching input in the educational context.

Table 3. Analysis Results of Teaching Process

Third-Level Index	M	Opinion of Experts	SD	CV%	IQR	Consensus
C20. Students' interest in learning	4.44	Strongly agree	.53	11.86	1	Congruence
C21. Students' study habits	4.67	Strongly agree	.50	10.71	1	Congruence
C22. Students' learning methods	4.44	Strongly agree	.53	11.86	1	Congruence
C23. Students' learning consciousness	4.67	Strongly agree	.50	10.71	1	Congruence
C24. Cooperation among students	4.44	Moderately agree	.53	11.86	1	Congruence
C25. Fit between teaching content and talent training objectives	4.78	Strongly agree	.44	9.23	1	Congruence
C26. Integration of professional ideological and political education	4.89	Strongly agree	.33	6.82	1	Congruence
C27. Teachers' moral performance	4.78	Strongly agree	.44	9.23	1	Congruence
C28. The degree of teachers' teaching energy input	4.56	Strongly agree	.53	11.57	1	Congruence
C29. Implementation of teaching plan	4.78	Strongly agree	.44	9.23	1	Congruence
C30. Systematic situation of teaching content	4.67	Strongly agree	.50	10.71	1	Congruence
C31. Control of teaching difficulty	4.89	Strongly agree	.33	6.82	1	Congruence
C32. Implementation of practical teaching	4.67	Strongly agree	.71	15.15	1	Congruence
C33. Rationality of proportion arrangement of practical courses	4.78	Strongly agree	.44	9.23	1	Congruence
C34. Usage of teaching methods	4.67	Strongly agree	.50	10.71	1	Congruence
C35. Scientific situation of curriculum arrangement	4.78	Strongly agree	.44	9.23	1	Congruence
C36. Teachers' Guidance Effect on Students	4.78	Strongly agree	.44	9.23	1	Congruence

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Third-Level Index	M	Opinion of Experts	SD	CV%	IQR	Consensus
C37. Establishment of quality evaluation system	4.67	Strongly agree	.50	10.71	1	Congruence
C38. Quality of teaching materials	4.56	Strongly agree	.53	11.57	1	Congruence
C39. Teaching management	4.56	Strongly agree	.53	11.57	1	Congruence

From Table 3, the analysis results indicate that the opinions of the 9 experts strongly agreed, with a mean score of 4.61, a standard deviation (SD) of .48, coefficient of variation (CV) of 10.44%, interquartile range (IQR) of 1, and the consensus of experts was congruence.

The mean scores, ranging from 4.44 to 4.89, represent the average response of experts for each aspect. Lower standard deviation values (e.g., .33 to 0.71) suggest that the experts' ratings are relatively close to the mean, indicating a high level of agreement among them. Lower CV% values (e.g., 6.82% to 15.15%) suggest consistent and low variability in the ratings.

It appears that the teaching process received high ratings, and there is a strong consensus among experts regarding the positive performance of various aspects of teaching, such as students' interest in learning, study habits, and teaching methods. The low standard deviation, coefficient of variation, and consistent interquartile range values support this conclusion, indicating a high level of agreement among the experts in their assessments.

Table 4. Analysis Results of Teaching Achievement

Third-Level Index	M	Opinion of Experts	SD	CV%	IQR	Consensus
C40. Degree of theoretical knowledge mastery	4.67	Strongly agree	.71	15.15	1	Congruence
C41. Practical operation ability	4.67	Strongly agree	.50	10.71	1	Congruence
C42. Ability to solve complex engineering problem	4.89	Strongly agree	.33	6.82	1	Congruence
C43. Training students' ability of coordination and cooperation	4.67	Strongly agree	.50	10.71	1	Congruence
C44. Possess good teamwork spirit	4.78	Strongly agree	.44	9.23	1	Congruence
C45. Training students' independent innovation ability	4.56	Strongly agree	.53	11.57	1	Congruence
C46. Participation in competition awards	4.67	Strongly agree	.50	10.71	1	Congruence
C47. The improvement of teachers' professional ability	4.56	Strongly agree	.73	15.95	1	Congruence
C48. The improvement of teachers' teaching ability	4.78	Strongly agree	.44	9.23	1	Congruence
C49. Orderly operation of all aspects of school personnel training	4.78	Strongly agree	.44	9.23	1	Congruence
C50. Continuous improvement and promotion of personnel training in schools	4.78	Strongly agree	.44	9.23	1	Congruence
C51. Students' satisfaction with learning and growth	4.89	Strongly agree	.33	6.82	1	Congruence
C52. Teachers' satisfaction with school education	4.78	Strongly agree	.44	9.23	1	Congruence

From Table 4, the report indicates that the opinions of 9 experts strongly agreed, with a mean score of 4.58, SD = .46, CV = 10.09%, IQR = 1, and a consensus among the experts, showing congruence. The experts' ratings suggest a high level of agreement and consensus on the strength of teaching achievement across all assessed criteria. The low standard deviations, low coefficient of variation values, and narrow interquartile ranges further support this conclusion. The "Strongly agree" ratings for each criterion underscore a positive assessment of teaching achievement.

Table 5. Analysis Result of Teaching Evaluation System for Engineering in Applied Universities in China

	Item	M	SD	F	CV	Cronbach's α
Teaching Background	7	4.6670	.4792	.2341	.1031	.838
Teaching Input	12	4.6853	.4416	.2013	.0948	.812
Teaching Process	20	4.6112	.4798	.2333	.1044	.911
Teaching Achievement	13	4.5798	.4614	.2184	.1009	.856
Total	52	4.6358	.4655	.2217	.1008	.823

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To analyze Table 5, we can observe and interpret the information provided for each item (Teaching Background, Teaching Input, Teaching Process, Teaching Achievement) based on the given metrics (M, SD, F, CV). From the analysis, we can infer the following about the teaching evaluation system for engineering at the applied university in China:

- The overall mean scores for each item are quite close to each other, indicating a relatively balanced perception of the teaching quality in all areas (Teaching Background, Teaching Input, Teaching Process, and Teaching Achievement).
- The standard deviations are relatively small, which suggests that the scores are not highly dispersed from their respective means. This indicates a certain level of agreement or consistency among the evaluators.
- The coefficient of variation (CV) values are all relatively low (around .10), indicating that the data's relative dispersion is relatively low compared to the mean. This implies that the data points are not widely spread, and the evaluations are somewhat consistent.

Overall, the analysis suggests that the teaching evaluation system is providing relatively consistent and balanced feedback on different aspects of teaching at the applied university in China. However, further interpretation and decision-making should consider additional factors, such as the specific evaluation criteria, the context of the evaluations, and any qualitative aspects not captured in this table.

Regarding Cronbach's α, when α > .7, the reliability of the questionnaire is in the normal range; when α > .8, the questionnaire's reliability is excellent. From the table, the overall reliability of the questionnaire is .823, showing reliability coefficients for four first-level indexes. The credibility of these indexes is high, making them reasonable and credible.

Table 6. Teaching Evaluation System for Engineering in Applied Universities in China

First-Level Index	Second-Level Index	Third-Level Index
A1. Teaching Background	B1. Talent Training Objectives	C1. Construction of quality standards for engineering talents training
		C2. Development orientation of engineering talents
		C3. Talent training reflects the characteristics of running a school
		C4. Synchronization of professional construction and industry development
	B2. Course Teaching Objectives	C5. Accuracy of course teaching objectives
		C6. Matching degree between course teaching objectives and students' career development
		C7. The degree of fit between the teaching objectives of the course and the formation of students' theoretical knowledge and practical ability
A2. Teaching Input	B3. Facility Conditions	C8. Investment in teaching funds
		C9. Input and use of teaching equipment
		C10. Construction and utilization of training room
	B4. Resource construction	C11. Construction of applied teaching materials
		C12. Construction and sharing of high-quality teaching resources
		C13. Real project case resource sharing of industrial enterprises
		C14. School-enterprise cooperation
	B5. Teacher status	C15. Teachers' professional titles
		C16. Teacher education
		C17. The proportion of teachers with more than half a year's attachment experience in enterprises
		C18. Proportion of full-time and part-time teachers
		C19. Teacher training opportunities
A3. Teaching process	B6. Students' learning situation	C20. Students' interest in learning
		C21. Students' study habits
		C22. Students' learning methods
		C23. Students' learning consciousness

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First-Level Index	Second-Level Index	Third-Level Index
		C24. Cooperation among students
	B7. Teaching resources	C25. Fit between teaching content and talent training objectives
		C26. Integration of professional ideological and political education
		C27. Teachers' moral performance
		C28. The degree of teachers' teaching energy input
		C29. Implementation of teaching plan
		C30. Systematic situation of teaching content
		C31. Control of teaching difficulty
		C32. Implementation of practical teaching
		C33. Rationality of proportion arrangement of practical courses
		C34. Usage of teaching methods
		C35. Scientific situation of curriculum arrangement
		C36. Teachers' Guidance Effect on Students
	B8. Quality management	C37. Establishment of quality evaluation system
		C38. Quality of teaching materials
		C39. Teaching management
A4. Teaching achievement	B9. Student ability cultivation	C40. Degree of theoretical knowledge mastery
		C41. Practical operation ability
		C42. Ability to solve complex engineering problem
		C43. Training students' ability of coordination and cooperation
		C44. Possess good teamwork spirit
		C45. Training students' independent innovation ability
		C46. Participation in competition awards
	B10. Teacher development	C47. The improvement of teachers' professional ability
		C48. The improvement of teachers' teaching ability
	B11. Effectiveness	C49. Orderly operation of all aspects of school personnel training
		C50. Continuous improvement and promotion of personnel training in schools
	B12. Satisfaction	C51. Students' satisfaction with learning and growth
		C52. Teachers' satisfaction with school education

Table 6 presents the Teaching Evaluation System for Engineering in Applied Universities in China, featuring a comprehensive index system with four first-level, 12 second-level, and 52 third-level indexes.

Table 7. Results of Consistency Test for the First-Level Index Judgment Matrix

Maximum Characteristic Root	CI	RI	CR	Consistency Inspection Results
4.102	.034	.882	.039	Adopt

Table 8. Consistency Test Results and Weights of the Second-Level Index Judgment Matrix Under the First-Level Index

First-Level Index	Weights	Maximum Characteristic Root	CI	RI	CR	Consistency Inspection Results
A1	0.0616	/	/	/	/	/
A2	0.1272	3.1	.05	.525	.017	adopt
A3	0.7183	3.018	.009	.525	.095	adopt
A4	0.0929	4.01	.003	.882	.004	adopt

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Table 9. Consistency Test Results and Weights of the Third-Level Index Judgment Matrix Under the Second-Level Index

Second-Level Index	Weights	Maximum Characteristic Root	CI	RI	CR	Consistency Inspection Results
B1	.8000	4	0	.882	0	adopt
B2	.2000	3	0	.525	0	adopt
B3	1.7879	3.006	.003	.525	.005	adopt
B4	.0818	4.123	.041	.882	.046	adopt
B5	.7393	5.134	.033	1.11	.03	adopt
B6	.7075	5.423	.106	1.11	.095	adopt
B7	.1364	13.3	.118	1.536	.077	adopt
B8	.1561	3	0	.525	0	adopt
B9	.4231	7.389	.065	1.341	.048	adopt
B10	.2272	/	/	/	/	/
B11	.2272	/	/	/	/	/
B12	.1225	/	/	/	/	/

Table 10. Weights of Third-Level Indexes in the Teaching Evaluation System for Engineering at Applied University in China

Third-Level Index Weights/Comprehensive Weight	Third-Level Index Weights/Comprehensive Weight	Third-Level Index Weights/Comprehensive Weight	Third-Level Index Weights/Comprehensive Weight
C1 0.333330/0.016435	C14 0.680000/0.007074	C27 0.243420/0.023856	C40 0.039330/0.001546
C2 0.333330/0.016435	C15 0.045210/0.004250	C28 0.133470/0.013081	C41 0.352550/0.013859
C3 0.166670/0.008217	C16 0.075120/0.007062	C29 0.137020/0.013429	C42 0.161910/0.006365
C4 0.166670/0.008217	C17 0.291280/0.027384	C30 0.020230/0.001983	C43 0.110590/0.004348
C5 0.100000/0.001233	C18 0.188740/0.017744	C31 0.040060/0.003926	C44 0.208090/0.008180
C6 0.100000/0.001233	C19 0.399650/0.037572	C32 0.161890/0.015866	C45 0.085760/0.003371
C7 0.800000/0.009861	C20 0.187330/0.095203	C33 0.110560/0.010835	C46 0.041750/0.001641
C8 0.128500/0.002921	C21 0.200370/0.101830	C34 0.029740/0.002915	C47 0.250000/0.003518
C9 0.276610/0.006288	C22 0.476410/0.242117	C35 0.033810/0.003314	C48 0.750000/0.014228
C10 0.594890/0.013524	C23 0.083280/0.042324	C36 0.047140/0.004620	C49 0.181818/0.003838
C11 0.061670/0.000642	C24 0.052610/0.026737	C37 0.125000/0.014011	C50 0.818181/0.017270
C12 0.061670/0.000642	C25 0.015230/0.001493	C38 0.125000/0.014011	C51 0.800000/0.009107
C13 0.196670/0.002046	C26 0.027430/0.002688	C39 0.750000/0.084068	C52 0.200000/0.002277

The tables "Table 8-10" present the consistency test results and weights of the second-level and third-level index judgment matrices, respectively, under the first-level and second-level indexes in the teaching evaluation system for applied universities in China. The consistency test results are used to assess the reliability and consistency of the judgments made by the evaluators. In the consistency test, the RI value of the second-level matrix is 0, and the second-level matrix itself already exhibits consistency. Therefore, consistency tests were not conducted for A1, B10, B11, and B12. Only the weights were calculated for these indexes.

The table shows the results of a consistency test for a judgment matrix. The CR value being less than .1 suggests that the judgments made in the matrix are considered to be sufficiently consistent for use in decision-making. This is a positive result, as it indicates that the decision-makers' judgments align reasonably well with the principles of the Analytic Hierarchy Process or a similar decision-making methodology.

The tables suggest that most of the judgments made by the evaluators in the teaching evaluation system are consistent and reliable. The consistency tests are crucial for ensuring the accuracy and validity of the evaluation system, and the adoption of most of the tests in both tables indicates that the system's structure is reliable and well-balanced.

5. Conclusion

The Teaching Evaluation System for Engineering at Applied Universities in China serves as a robust tool to ensure the quality of engineering education. Through well-defined evaluation criteria, diverse data collection methods, effective feedback mechanisms, and a strong emphasis on faculty development, the system promotes teaching excellence, enhances the learning experiences of engineering students, and contributes to the overall advancement of engineering education in applied universities in China. Continuous refinement and adaptation of the system will be essential to meet the evolving needs of engineering education and maintain high teaching standards in the dynamic engineering field.

This paper, based on the CIPP model, constructs a teaching evaluation system for engineering at applied universities in China. The system is applied to the engineering courses at Sichuan University of Science & Engineering to verify the feasibility and operability of the evaluation index system. The results offer guidance and assistance for improving engineering courses at the university, along with strategies to address identified issues in the teaching process.

The CIPP model, designed to focus on developmental evaluation rather than solely obtaining results, proves applicable to the teaching evaluation of engineering courses at Sichuan University of Science & Engineering. The model's four evaluation stages encompass a comprehensive assessment of preparatory work, mid-term work, and outcomes in engineering teaching. This approach is particularly valuable for practical teaching components often found in engineering courses.

The final evaluation index system, comprised of four first-level indexes, 12 second-level indexes, and 53 third-level indexes, is well-structured. When applied to Sichuan University of Science & Engineering, the evaluation results highlight areas where attention to teachers, personal development, follow-up training, and the school's orderly administration and sustainable development plan may be lacking.

However, challenges and areas for improvement are identified in the construction of the teaching evaluation index system. Difficulties include the project's complexity, completeness, and scientific nature of index selection. Data collection poses challenges due to the subjectivity of teaching evaluation, individual differences in understanding, and varying evaluation criteria. Identifying the effect of evaluation on teaching is also challenging, and the evaluation results may not be effectively utilized for continuous improvement.

The CIPP model-based teaching evaluation system, established through literature research and focus groups, is promising but needs further refinement. The limited number of participants and cases, along with the need for more extensive practice and case analysis, underscore the necessity for additional verification of the system's feasibility and operability. Ethical considerations, including informed permission and confidentiality, are paramount in research, and the findings' impact on participants and institutions must be carefully considered.

Despite the study's limitations, such as the sample size and scope, the research findings provide valuable insights into the effectiveness of the Teaching Evaluation System within the specific context of the study. Recommendations stemming from these insights can potentially enhance the Teaching Evaluation System for Engineering at Applied Universities in China. Strategies may include improvements to faculty development programs, refinement of student feedback mechanisms, and the integration of emerging engineering fields into the evaluation process.

6. Suggestions

Future research in the field of teaching evaluation systems for engineering education could expand by incorporating emerging technologies into the assessment process, examining global comparative perspectives, and adopting a mixed-methods approach. Longitudinal studies tracking the sustained impact of these evaluation systems over time, along with a focus on inclusivity, diversity, and faculty well-being, can provide a more comprehensive understanding. The use of case studies involving multiple universities and engaging a broader range of stakeholders, including industry professionals and policymakers, would offer insights into the nuanced challenges and successes of implementation. Additionally, exploring the ethical considerations associated with these systems and conducting in-depth analyses of their impact on student employability and industry alignment would contribute significantly to the field. Overall, these directions can enhance the depth and breadth of future research, guiding improvements in teaching evaluation systems and their alignment with the evolving needs of engineering education. The research reveals that Chinese data science professionals exhibit strong innovation potential, with a robust structural validity and favourable influence relationships. The study proposes a comprehensive model of creativity abilities among these professionals, aiming to enhance their competitiveness and creativity in the field. This research lays the theoretical groundwork for fostering innovation within the university setting (Zhang, Y., Sangsawang, T., & Vipahasna, P., 2023). Activating prior knowledge, fostering idea exchange, building organizational knowledge, and generating innovative ideas. This comprehensive instructional model emphasizes globalization, collaborative efforts, and economic growth as key drivers for enhancing data science education quality (Li, Y., Sangsawang, T., & Vipahasna, K., 2023).

7. Co-Author Contribution

The authors affirmed that there is no conflict of interest in this article. Author1 carried out the field work, prepared the literature review and overlook the writeup of the whole article. Author2 wrote the research methodology and did the data entry. Author3 carried out the statistical analysis and interpretation of the results.

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