Research on Five-in-One Multi-integration Practical Teaching and CIPP Talent Training Assessment

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Abstract. In order to response the spirit of the 20th National Congress of the Communist Party of China and the practical teaching concept of cultivating students' application ability as the core, a practical teaching system suitable for the characteristics of the profession has been established and improved to ensure the scientific, rigorous, standardized, and high-level operation of practical teaching. This will improve the quality of practical teaching and enhance students' employability and entrepreneurial competitiveness. The National Experimental Teaching Demonstration Center for Information Technology at Tibet University (NETDCIT) has established a Five-in-One system supported by student-centered, teacher-guided, project-driven, institutional safeguards, and fair and just evaluation based on the new engineering education goals and the current situation of the communication engineering profession at Tibet University. This system aims to cultivate reliable, employable, and retentive talents with the characteristics of unity, diligence, practicality and innovation. The CIPP model is adopted to evaluate the practical teaching reform, and the results show that the NETDCIT has achieved good results in practical teaching reform. This paper focuses on the Five-in-One practical reform and CIPP evaluation.

Keywords: Reform of Practical Teaching, Five-in-One, Talent Cultivation, CIPP.

1 Introduction

Many universities have carried out a lot of exploration in practical teaching, especially in the field of engineering education[1]. The researches focused on theoretical teaching or single practical skills training, lacks case studies of the application of CIPP evaluation model in the practical teaching evaluation of communication engineering, and lacks in-depth research on the application of the "five in one" model in communication

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engineering[2-4]. The evaluation mechanism and index system of teaching reform effect have not been fully discussed in communication engineering majors[5-6]. The major of communication engineering involves core courses such as signals and systems, communication principles, data communications, and mobile communications, and requires students to master skills such as design, implementation, management, and maintenance of communication networks. The development of this professional field requires continuous innovation of educational models to adapt to technological advances. The CIPP evaluation model is applied to establish a scientific evaluation system, and the application of the "five in one" model in communication engineering is explored, in order to improve the comprehensive quality and employment competitiveness of students, so as to evaluate the effect of practical teaching reform. The results show that the teaching reform has achieved remarkable results, which provides reference for the education of communication engineering.

2 Guiding Ideology

Education is the key to the country and the Party. President Xi Jinping has pointed out that “the high education system of a country needs strongly supported from a group of first-class universities. The level and quality of this group of universities determine the level and quality of the higher education system.” The report of The 20th National Congress of the Communist Party of China proposed that education, science and technology, and talents are the basic and strategic to support the comprehensive construction of a socialist modernization country. We should accelerate to construct the high-quality education system, to develop quality education, and promote education fairness. The Overall Plan for Deepening the Evaluation Reform of Education in the New Era is issued by the Central Committee for Comprehensively Deepening Reform emphasize that different types of education should adopt different result evaluations, strengthen process evaluation, and build a scientific evaluation system and mechanism for education. The Implementation Plan for the Review and Evaluation of Undergraduate Education in General Higher Education Institutions (2021-2025) issued by the Ministry of Education has pointed out that higher education institutions should take multiple measures to achieve talent training transformation. The NETDCIT deeply implements the spirit of the Ministry of Education’s opinions on the quality of undergraduate education and teaching reform in higher education institutions, in accordance with the requirements of the school to cultivate “Reliable, Usable, and Stay-able” talents with the goal of “Unity, Diligence, Practicality, and Innovation”. The NETDCIT closely integrate with economic and social development and focus on improving students’ practical ability and innovation spirit, and aims to enhance the core competitiveness of graduates in scientific research, employment, entrepreneurship, and other aspects. The NETDCIT promotes the deepening of practical teaching reform and focuses on improving education quality.

3 Build a New Practical Teaching System Guided by the Ability Element for Communication Engineering Majors

The NETDCIT is based on the educational positioning of communication engineering majors at Tibet University and the characteristics of information professionals demanded by the economic and social development of Tibet Autonomous Region. With a focus on creating practical abilities for college students, following the rules of practical teaching, we will construct a Five-in-One practical teaching model that emphasizes "Students as the main body, Teachers as guides, Project-driven motivation, Institutional guarantees, and Fair just evaluation."

3.1 Practice Teaching Reflects the Subjectivity of Students

Cognitive psychologist Bruner believes that "Cognition is an active process, and learners should not be passive recipients of information, but active participants in the process of acquiring knowledge[7]." The NETDCIT values and respects the subjective factors of students in the teaching process, changes the practice of emphasizing knowledge imparting while neglecting ability cultivation and quality development, emphasizes individualized instruction, highlights the status of student subjects, designs multidimensional practical teaching goals based on different learning interests, motivations and future career paths to promote multi-dimensional and three-dimensional autonomous development for students at different levels. This enhances their ability to fit into economic and social development independently as well as their lifelong learning abilities[8].

3.2 The Guidance of Practical Teaching Teachers

Han Yu, a great litterateur in the Tang Dynasty, in his book "On Teachers" had stated that "ancient scholars must have teachers[9]. Teachers, therefore, impart knowledge and receive guidance to dispel doubts." This highlights the guiding role of teachers in the teaching process. In today's society where cultural values intersect and social development is rapidly changing with new technologies emerging at a high speed, College students' worldviews, life perspectives and values are constantly being refreshed. As a result, their actions and cognition often fall into predicaments. Under these circumstances, The NETDCIT has established a four-dimensional mentorship system to guide students in their studies as well as help them navigate through any confusion they may have about their life goals.

3.3 Project-driven Practical Teaching

Update experimental projects in a timely manner based on scientific and technological development and industry needs. The NETDCIT sets up special funds to support the development of new practical projects combined with local economic construction and

scientific and technological development. New comprehensive and design projects are launched every year. Under the guidance of their mentors, students in the laboratory affiliated with The NETDCIT conduct research-based learning independently, design experiments independently, complete experiments independently, and manage experiments independently to stimulate their innovative thinking and awareness while improving their innovation practice ability. At the same time, The NETDCIT improves project-based discipline competition mechanisms. In addition to providing material rewards for students who have won awards in city-level or higher-level subject competitions, they also receive bonus points in comprehensive evaluations for excellence promotion recommendations as well as priority recommendation for exchange programs both domestically and abroad or participation in teachers' research projects.

3.4 Institutional Guarantee for Practical Teaching

Institutions are regulations or action guidelines that everyone is required to follow. Without institutions, practical teaching would be like a bird with broken wings and unable to function properly. Therefore, in order to ensure the normal operation of practical teaching activities at the NETDCIT, it has established a normalized student inflow and outflow system. On one hand, this system encourages students who live in the laboratory belonging to the NETDCIT while also providing more students with an opportunity for improvement; on the other hand, based on national, autonomous region and school laws and policies, The NETDCIT has formulated a series of guiding and binding rules and regulations such as attendance management, training selection process, elimination at end-term exams , asset management , equipment sharing , allocation of equipment and software resources etc., which provide activity guidelines for continuous healthy operation of practical teaching at the NETDCIT.

3.5 Fair and Just Evaluation of Practical Teaching

Multi-dimensional practical assessment indicators are constructed that place greater emphasis on students' progress and effort during the practical process. Fully utilize the function of evaluation to promote development, and conduct multi-dimensional, three-dimensional comprehensive evaluations of students' experimental design ability, observation ability in experiments, judgment ability, operational ability, language expression ability, data processing ability, logical reasoning ability, experimental report writing ability, interpersonal communication skills and team spirit based on the characteristics of professional courses. At the same time, the experiment file for each student is established to evaluate their various experimental abilities for developmental purposes to encourage students to take responsibility for themselves and guide them towards becoming reflective learners.

4 Building Scientific Evaluation Indicators for Practical Teaching

As an important way to cultivate “both popular and professional” talents, practical teaching is a key link in consolidating theoretical knowledge, cultivating innovative consciousness, and improving hands-on ability. It is an important mission in the talent training system of the new era. However, in the process of cultivating students' abilities, due to the difficulty in quantifying the attributes of practical teaching objectives, there are formal problems with assessment and evaluation of practical teaching. The evaluation methods are single and the evaluation effects are not obvious. The NETDCIT has explored a path of characteristic evaluation for practical teaching under the Five-in-One practical teaching framework.

4.1 Indicator Design Guiding

In 1967, D.L. Stufflebeam, an American education evaluation expert, proposed a decision-making evaluation method called CIPP (Context Evaluation, Input Evaluation, Process Evaluation and Product Evaluation)[10]. After more than half a century of practice, the CIPP model has been fully validated and applied in the field of education. The CIPP model combines the Five-in-One approach to evaluate the basic environment for practical teaching at the NETDCIT, resource allocation, teaching process and teaching outcomes. On one hand, it dynamically monitors the entire process of practical teaching in real-time; on the other hand, it realizes that from student practice sites to funding sources to student learning elements and practice framework design evaluations must handle well both single and multiple dimensions as well as theoretical and practical connotations when selecting evaluation indicators. Therefore, based on the CIPP model and Five-in-One practical teaching mode we construct a practical teaching evaluation system which not only selects evaluation indicators from four dimensions: context, background information input, processes, outcomes, but also embeds precision requirements ensuring that all indicators are observable, evaluable, quantifiable with reliable results so that scientific assessment systems can better serve the NETDCIT practical teaching.

4.2 Evaluation Methods

The NETDCIT adopts the CIPP model to evaluate the design indicators of the Five-in-One practical teaching mode, including Delphi method, interview method and literature analysis method.

Firstly, the Delphi method is applied to solicit opinions from relevant experts in the field of education[11]. The Delphi method was used in designing evaluation indicators at each stage. At the beginning of indicator design, experts were consulted on what experimental environmental factors are needed for practical teaching, what inputs are required from schools, colleges and majors, which indicators can be used to evaluate and monitor implementation processes, and how to evaluate implementation effects.

After designing the framework and detailed evaluation indicators of the evaluation indicator system, experts were invited to review them and quantitatively assess each indicator according to a five-level Likert scale (not important, slightly important, somewhat important, relatively important or very important), while revising inappropriate indicators. A total of 15 people were invited by The NETDCIT to participate in indicator consultation and review: one school-level leader; three college-level leaders; six experts who have been engaged in educational reform research for many years; five industry experts.

Secondly, the interview method was used to conduct interviews with front-line practical teachers and senior students from a certain college, collecting on-site data as supplementary information for expert consultations. The content of interviews is consistent with that of Delphi methods. The NETDCIT conducted in-depth interviews with nine front-line practical teaching teachers (including three outstanding teachers) and randomly selected 27 senior students.

Finally, literature research method was employed. An effect evaluation index system suitable for blended learning based on CIPP was designed[12]. An evaluation index system measuring service-learning project effects based on CIPP was designed [13]. The author applied CIPP model into evaluating practical teaching [14]. The authors evaluated animal science professional practice teaching using CIPP[15]. The authors evaluated innovation entrepreneurship education using CIPP[16]. The CIPP model was applied into evaluating Sino-foreign cooperative education integration affection [17]. The excellent indexes compiled in these researches also broadened ideas for this study of evaluation indexes.

4.3 Evaluation Indicators Constructed

Preliminary indicator of CIPP. Based on the CIPP model, this study collected first-hand data through Delphi method, interview method and literature research method, and cleaned, analyzed and organized the data to ensure its validity. A preliminary Five-in-One four-level CIPP evaluation indicator system was constructed, with 4 primary indicators in the criterion level, 10 secondary indicators in the implementation level, and 40 specific evaluation indicators in the quantification level[18]. The execution level corresponds to the quantification level.

Formal CIPP Evaluation Index. After the preliminary completion of the CIPP evaluation index system, leaders, experts, teachers and university students who participated in the previous consultation and data collection were invited again to review the constructed evaluation index system. The review mainly includes two aspects: suggestions for the framework of the index system; and a five-level Likert scale assessment of quantitative indicators.

Regarding the framework of the index system, leaders, experts, teachers and university students generally agreed with it but raised objections to a few evaluation indicators. For example, appropriateness and practical basis are two secondary indicators. The former mainly refers to objective factors while the latter is subjective. Therefore, the

construction status of professional practice/training platforms under original implementation level's practical basis indicator is an objective reality that belongs more appropriately to appropriateness indicator.

In terms of results from using a five-level Likert scale assessment on quantitative indicators at implementation level, those with an average score greater than 4 points were retained as standards. Those with a score lower than 4 points include the proportion of practical courses and students' expectations for participating in practice. According to the survey, most of the practical courses are interspersed in theoretical courses during actual teaching. It is difficult to reflect the needs of professional training objectives for practice by separately offering practical courses, while practical course hours are a more realistic indicator. The low score for students' expectations for participating in practice is mainly due to students having biased understanding towards comprehensive and innovative practical activities, so guidance and publicity work need to be done well. After optimizing the indicators, a total of 38 detailed CIPP evaluation indicators were finally constructed into three layers, as shown in Table 1.

Table 1. CIPP evaluation index system of Five-in-One practice teaching mode

Primary indicator (Guideline layer)	Secondary indicator (Implementation layer)	Third-level indicator (Quantization layer)
Background Evaluation	Objectives	The importance of practical skills by instructors
		The importance of practical skills in professional planning
		Percentage of practical courses
	Suitability	Proportion of professional practical skills courses (self-organized) conducted
		(Carry out) practical skills courses for related professions
		Proportion of full-time practice teachers
		Construction of professional practice/training platform
	Practice Basics	Students' interest in practice
		Awareness of non-practice dedicated teachers' involvement in practice teaching
		Hands-on campus atmosphere
Input evaluation	Hardware input	The school's financial investment in practical teaching
		The degree of school support for practice sites
		The extent of the school's support for practical equipment
		Construction of professional on-campus training platform
		Construction of professional off-campus practice bases
	Software input	Ratio of "two-teacher" teachers

		Time for teachers to instruct students in practical skills
		Number of teachers instructing students in practical skills
Process Evaluation	Practice Development	Total number of practices
		Number of innovative, integrated practices
		Total number of participating practicing teachers
		Total number of students participating in the practice
	Practice Management	Completeness of the rules and regulations related to practice activities
		Establishment of a long-term mechanism for practice activities
		Comprehensive practice, project planning (purpose, form and process, etc. description)
		Skill development objectives or plans for hands-on activities
	Quality Control	Completeness of the monitoring system for practice activities
		Whether there is feedback and reflection on practical activities
		Engagement of students and faculty in practice
		Quality of practice activities
Output evaluation	Objective effect	Number of student participants
		Awards for participation in competitions and projects
		Improvement of students' practical skills
		Post-reform vocational qualifications compared to pre-reform
		Increase in the number of students
	Subjective effect	Student engagement (interest in integrated practice)
		Students' subjective evaluation of the effectiveness of the practice
		Intra-professional participation in innovation, integrated practical activity formation
		Promotion of human resource development goals

4.4 Reflection on Evaluation Indicators

Close Integration with Evaluation Objectives. The design of the evaluation indicator system in this study refers to the relevant regulations of the Ministry of Education and is completed by personnel with diverse backgrounds, ensuring the standardization of

the evaluation indicator system and meeting the target needs of assessment subjects. Moreover, CIPP is a scientifically validated model that has been tested in practice.

Dynamism and Openness. The determination of second- and third-level indicators in this study adopts a dynamic process that keeps up with changes in scenarios, allowing for adjustments to implementation layer and quantification layer indicators while maintaining relevance to the evaluation model.

Continuous Improvement. The purpose of assessment is to improve teaching quality and correct deviations. Based on CIPP-designed evaluation indicator systems, it can reflect procedural aspects of practical teaching, avoiding traditional evaluations' tendency to overlook processes while focusing solely on results. Additionally, “model indicators” can be selected from second- or third-level evaluation indicators designed for promoting reform models for practical teaching as well as evaluating models.

Improvement Data Dimension of Evaluative. Determination at level three quantification relies heavily on subjective data; objective criteria are lacking; furthermore, there is insufficient comparability among different students' evaluative data collected during research surveys conducted horizontally across departments, programs, faculties, schools etc. In addition, authenticity checks need strengthening when collecting subjective survey data during evaluations; therefore, combining re-evaluation by higher authorities along with fine-grained assessments would make evaluations more effective.

5 Achievements

Firstly, the number of the papers published by students have increased year by year. In the past three years, a total of 28 papers are the direct research results of students who participate in the "Five in one" teaching mode have been published, including 1 SCI and 20 EI papers. The students who do not participate have no similar results.

Secondly, students actively participate in the innovation and practice competition. There are 93 competitions include 89 provincial or above awarded 100%, the first, second and third prizes are 15, 34 and 40. In the past three years after the "Five in one" teaching model, compared with the previous (without the teaching model reform), the number of participants had increased 35% at an average annual, and the number of awards has increased 38% every year. Since the implementation of the teaching reform, students participated have submitted more than 20 patents, of which 9 have been approved, an increase of 300% compared with the patent applications in the same period of history. Students hosted or participated in 12 scientific research projects, included 11 national undergraduate innovation plan "Big Innovation" projects, 6 national projects, and 4 provincial projects. All these projects are directly related to practical teaching reform.

Finally, the students from NETDCIT benefited from the practical teaching reform and all achieved high quality employment. In the past three years, more than 50% of the students chose to continue their PhD in information and communication engineering, and 6 students started their own business started by information technology created more than 80 jobs for others.

6 Conclusion

The NETDCIT has constructed a Five-in-One integrated training characteristic system focusing on "students as the main body, teachers as the guides, project-driven motivation, institutional guarantees, and fair and just evaluation", aiming to cultivate reliable, employable, and retainable talents with the characteristics of unity, diligence, practicality, and innovation. It has also built a scientific multidimensional practice teaching evaluation index system based on the CIPP model, while continuously improving the practice teaching reforms and dynamically adjusting the practice teaching model to cultivate even higher-quality versatile talents.

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