

RESEARCH ON THE EMBEDDED METHOD AND PROCESS COMPETENCY INDEX OF TEACHER COMPETENCY DEVELOPMENT IN VOCATIONAL COLLEGES AT THE UNDERGRADUATE LEVEL

Xiaoshu Bian^{1*}, Yu Qiao²

^{1,2}*Faculty of Education Management Major, Suan Sunandha Rajabhat University, Bangkok, Thailand*

E-Mail: s64584951038@ssru.ac.th^{1*}, qiaoyu37@qq.com²,

ABSTRACT

China's industrial upgrade has led to an increased demand for skilled talent, with undergraduate vocational education playing a crucial role. The quality of education is heavily dependent on the professional ability of teachers. This study assesses the influence of embedded methods on teachers' competencies, such as self-directed learning and problem-solving, through the use of tools such as surveys and interviews. Results indicate that teachers' abilities improve with experience and reflection in their work. Factors such as school resources and personal motivation significantly impact teacher development.

Keywords: Vocational Undergraduate Education, Teacher Competency Development, Embedded Methods, Process Competency Index

INTRODUCTION

With the rapid development of China's high-tech industry [1] and the advancement of intelligent manufacturing have resulted in a growing need for high-end skilled talents [2]. However, the skilled talents cultivated by vocational education at the junior college level cannot meet this demand [3], emphasizing the significance of vocational education at the undergraduate level. Currently, vocational colleges in China are facing issues such as a low academic standard among teachers, insufficient subject teaching ability, limited integration of industry and education, and a lack of scientific research capability [4]. The current “double teacher” vocational education teacher standard is unable to meet the demands for high-quality development of vocational education at the undergraduate level [5]. Therefore, high vocational colleges that have been elevated to the undergraduate level and those planning to make the transition urgently need to enhance the abilities of their teachers [6]. Professional development for teachers is essential because it ensures that teachers are continuously learning and provided with the opportunity to stay updated on new developments that can help them effectively engage their students [7].

In the development of teachers' abilities in vocational colleges, research has demonstrated that the utilization of embedded methods can enhance teachers' capacity to apply theoretical knowledge, foster

innovative teaching strategies, and encourage self-reflection among teachers [8]. The Process Competency Index is a method for assessing teaching practice [9], which can help evaluate teachers' ability to apply theories and skills in the classroom, as well as monitor students' learning progress [10]. By assessing the teaching methods used by teachers, we can objectively evaluate the impact of implementing embedded methods. Job-embedded professional development (JEPD) refers to teacher learning that is grounded in day-to-day teaching practice and is designed to enhance teachers' content-specific instructional practices with the intent of improving student learning [11].

The significance of this study lies in its provision of an effective method for vocational college teachers to enhance their professional abilities. Additionally, it offers theoretical support and practical guidance for the high-quality development of vocational education.

OBJECTIVE

Goal 1

To investigate the impact of embedded instructional methods on enhancing the skills of teachers in undergraduate vocational colleges.

Goal 2

The Process Competency Index is used to objectively assess the extent and effectiveness of teachers' application of embedded methods, as well as students' learning progress.

Goal 3

Based on the research findings, this paper proposes strategies to enhance and optimize the implementation of embedded methods by teachers to effectively foster the professional development of teachers in undergraduate vocational colleges.

Research Scope

Population Boundaries

A sample of 100 teachers from five high-level higher vocational schools in Shandong Province, China, which are preparing to be upgraded to the undergraduate level, were randomly selected to participate in the study. Most of the participants were female (71%), with ages randomly distributed between 30 and 50 years old. The distribution of professional titles was as follows: lecturers (42%), associate professors (51%), and professors (7%).

Variable Range

Teachers' background information includes gender, major, professional title, age, and teaching experience. School environmental indicators such as student composition, teacher experience, principal stability, teacher education distribution, and regional distribution are used to account for differences between schools. These factors may influence teachers' willingness and capacity to implement embedded methods.

Timeframe

In this study, the data of teachers' teaching practices was gathered every six months over a two-year period, totaling four times. This time span was chosen because it is long enough to capture the changes and developments in the implementation of the embedded approach by teachers.

METHODOLOGY

Survey Methodology

Teachers are encouraged to utilize embedded methods in their teaching practices and to document their own application and effectiveness in practice. Furthermore, teachers engage in collaborative research with their colleagues to explore teaching methodologies and their impact on student learning.

Study Procedures

The study was conducted over a two-year period, during which a total of four data collections took place. First, teachers participated in an online training on integrated teaching methods and were then encouraged to apply the theoretical knowledge and skills learned in their teaching practice. During the teaching process, teachers need to document their application of the embedded approach and its effectiveness. At the end of each semester, we gather data on teachers' instructional practices to offer timely feedback and assist them in adjusting their teaching strategies.

Information Collection

In this study, we utilized a comprehensive indicator collection table to gather data specifically designed to evaluate how teachers implement embedded methods in their teaching practices. The collection includes a variety of indicators related to teachers' instructional practices. In addition, based on the characteristics of teacher skill development in undergraduate vocational colleges, we have included two key focus areas: experimental teaching and enterprise resources. All data collection is conducted in strict compliance with ethical standards to ensure the protection of participants' privacy. From Table 1.

Table1: Indicator collection table for the application of embedded methods to teaching practice.

Formulation of teaching objectives	Design of course content	Choice of teaching methods	Utilization of teaching resources	Implementation of teaching evaluation	Teaching and research
Clarity	Hierarchical	Instructional goal fitness	Reasonableness of teaching	Evaluation of teaching quality	Pedagogical improvements
Measurability	Fit with teaching objectives	Adaptability of teaching resources	Digital teaching methods	Evaluation of the teaching process	Teaching self-evaluation
adaptability	Completeness	Adaptability of student	Enterprise Resources	Evaluation of teaching	Peer reviews
	Adaptability	Teaching process management	Experimental teaching	Student Reviews	
	pertinence	Student feedback			
	Innovative				

Data analysis

In the analysis, we propose a process capability index model for this study. From Table 2.

Table 2: capability index model

No	Capability	Weight
1	Formulation of Teaching Objectives:	0.2
2	Design of course content:	0.3
3	Selection of teaching methods:	0.2
4	Utilization of Teaching Resources:	0.1
5	Implementation of Teaching Evaluation:	0.1
6	Teaching Research:	0.1

We used exploratory factor analysis to validate our proposed model. EFA is a technique used to determine the fundamental structure of multivariate observed variables and to address dimensionality reduction. As a result, EFA can synthesize variables with complex relationships into a few core factors. The process capability index measures the extent of variation that a process experiences in relation to its specification limits. It also helps us to compare different processes in terms of their optimal performance or whether they meet our expectations [12].

Results

Figure 1 summarizes the results of our data collection. The scores at all observation points followed a normal distribution, and the scores for each item varied among different teachers. The measurability of teaching goal setting, the hierarchy of teaching goal setting, the adaptability of curriculum content design, the innovation of curriculum content design, the selection of teaching methods, and the adaptability of teaching objectives, as well as the implementation of teaching evaluation and teaching improvement after research, show significant discrepancies in teachers' scores. This is consistent with variations among teachers with different years of experience and professional titles, Figure 1.

Figure 1

The summary of data collection.

		T1			T2			T3			T4		
		N	avg	SD	N	avg	SD	N	avg	SD	N	avg	SD
Formulation of teaching objectives	Clarity	100	59.75	5.01	100	69.43	6.44	100	79.28	7.18	100	89.61	7.97
	Measurability	100	60.27	11.66	100	65.53	13.07	100	71.63	13.51	100	77.65	14.92
	adaptability	100	69.37	5.00	100	77.71	5.88	100	85.34	7.32	100	93.31	8.27
	Hierarchical	100	70.22	11.59	100	72.46	12.96	100	74.61	13.59	100	76.83	13.86
Design of course content	Fit with teaching objectives	100	70.31	6.07	100	73.99	7.04	100	77.82	8.56	100	81.06	9.69
	Completeness	100	79.90	3.95	100	81.61	5.40	100	83.33	6.59	100	85.19	7.20
	Adaptability	100	70.79	11.39	100	73.22	12.75	100	75.53	13.50	100	77.22	14.62
	pertinence	100	60.37	9.88	100	63.51	10.73	100	66.23	12.06	100	69.28	12.80
	Innovative	100	59.19	14.02	100	61.52	14.32	100	63.04	14.51	100	64.34	15.03
Choice of teaching methods	Instructional goal fitness	100	70.34	11.91	100	72.29	12.52	100	74.21	13.23	100	76.19	13.11
	Adaptability of teaching resources	100	70.28	5.28	100	73.34	7.06	100	77.18	8.11	100	79.77	9.30
	Adaptability of student characteristics	100	60.04	8.79	100	62.36	9.36	100	63.99	9.52	100	65.55	10.14
	Student feedback	100	69.42	8.78	100	71.34	9.54	100	73.81	9.41	100	76.35	10.36
	Teaching process management	100	69.26	4.96	100	71.45	6.70	100	73.05	7.88	100	74.46	8.91
Utilization of teaching resources	Reasonableness of teaching materials	100	80.58	4.51	100	81.17	6.31	100	82.56	7.61	100	83.44	9.46
	Digital teaching methods	100	70.42	5.03	100	71.33	6.14	100	71.99	7.62	100	73.16	8.76
	Experimental teaching	100	70.78	5.25	100	76.68	7.04	100	82.95	8.02	100	89.18	9.30
	Enterprise Resources	100	60.97	10.63	100	62.36	11.20	100	62.39	14.68	100	61.91	15.97
Implementation of teaching evaluation	Evaluation of teaching quality	100	71.07	11.09	100	72.85	12.54	100	74.97	13.02	100	77.19	14.46
	Evaluation of teaching effectiveness	100	69.57	12.35	100	71.62	12.69	100	73.26	13.62	100	75.09	13.41
	Evaluation of the teaching process	100	68.20	15.13	100	76.43	15.52	100	84.29	15.12	100	91.70	15.49
	Student Reviews	100	57.59	15.23	100	60.34	15.89	100	62.49	16.56	100	64.32	17.16
Teaching and research	Peer reviews	100	70.01	12.47	100	71.17	12.61	100	73.82	13.09	100	76.03	13.89
	Teaching self-evaluation	100	70.15	3.82	100	71.20	5.76	100	73.15	6.75	100	74.51	7.74
	Pedagogical improvements	100	57.17	14.68	100	62.28	15.29	100	67.46	15.55	100	72.29	15.61

Using the collected data, we created a line chart that visually represents the increase in the scores at each observation point of teacher competence development. The embedded approach has various facilitative effects on all teacher competency observations. Among these aspects, the proficiency of teachers in five areas—specifically, the clarity, measurability, and adaptability of teaching goal setting, the evaluation of teaching processes, and experimental teaching—has shown the most significant growth. In contrast, the self-evaluation of enterprise cases, the rationality of teaching material utilization, digital teaching, and teaching research have seen minimal improvement.

Figure 2

The scores at each observation point of teacher competence development.

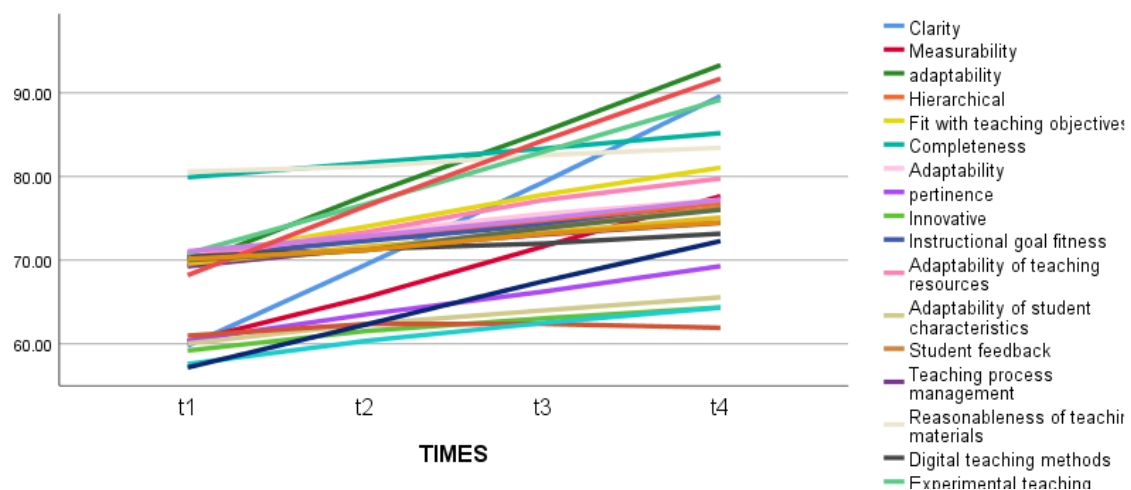


Figure 3 displays the test results of our Process Capability Index model [13]. After incorporating embedding into teaching practice, the process ability index of teachers has improved. The improvement value has been relatively consistent each semester, and the improvement rate has decreased gradually over the years.

Figure 3

The test results of our Process Capability Index model

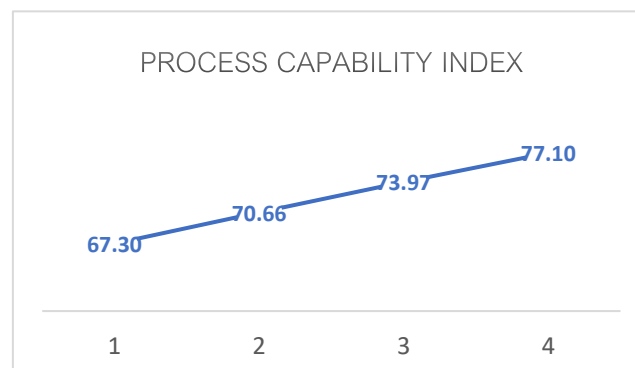
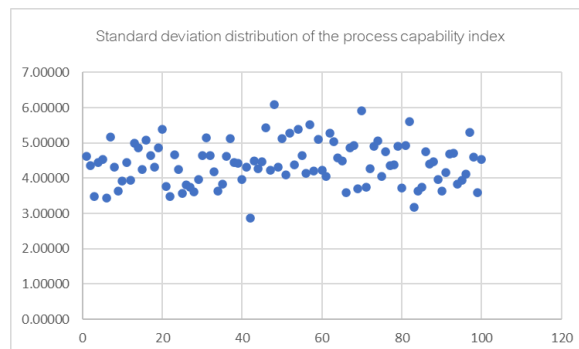


Figure 4 shows the standard deviation distribution of the results of 100 teachers collected four times using our process competency index model. Most of the teachers demonstrated a significant

improvement in the process competency index score after incorporating embedding into their teaching practice. However, a very small number of teachers showed only minimal improvement in their abilities.

Figure 4
The standard deviation distribution of the results



Conclusion and Future Work

In conclusion, our analysis of data collected from 100 vocational college teachers over a two-year period has provided valuable insights into the evolving capabilities of teachers when embedded methods are applied to their teaching practices. The proposed process competency model, which utilizes a statistical approach, has effectively revealed the development of various competencies among teachers during this process and assisted in assessing the appropriateness of embedded methods for enhancing the competencies of teachers in vocational colleges at the undergraduate level [14].

After implementing embedded methods in teaching practice, we observed a gradual improvement in teachers' abilities over time, although the rate of improvement varied among individuals. Notably, the development of teachers' abilities showed the most significant progress in five aspects: the clarity, measurability, and adaptability of setting teaching goals, as well as the evaluation of teaching processes and experimental teaching.

However, there was minimal improvement in the four areas related to business cases, the appropriateness of teaching materials, digital teaching, and self-assessment in teaching research. Despite this, the overall results suggest that the findings are applicable to the teaching practices of instructors in vocational colleges at the undergraduate level, contributing to the enhancement of their professional development.

Future work will focus on implementing the research results in practical applications. Teachers are encouraged to focus on developing the three most rapidly advancing aspects of teaching goal setting: clarity, measurability, and adaptability. Attention to evaluating the teaching process and implementing experimental teaching is crucial for enhancing teachers' abilities, which can be achieved through regular seminars and observations.

For the slower-progressing aspects of business cases, it is recommended to increase investment and improvement in teaching materials, digital instruction, and self-evaluation in educational research for both schools and teachers. Continuous follow-up and feedback mechanisms should be established, with schools regularly evaluating teachers' practices to provide timely feedback and support the adjustment of teaching strategies. Increased investment and improvement in these areas is encouraged. Future research should explore the impact of different factors, such as student characteristics and the teaching environment, on the frequency and effectiveness of teachers' use of embedded methods in practice. Enhancing control over these variables or using alternative research methods can improve the

reliability and validity of research outcomes. Furthermore, future research should concentrate on examining the attributes of educators who derive less benefit from embedded methods, investigating their techniques and level of enthusiasm for implementation, and identifying specific strategies to improve their involvement with embedded approaches. This will contribute to a more comprehensive understanding of the variations in teachers' use of embedded methods and provide more specific recommendations for future teacher training.

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