

Research on the Construction of Course Diagnosis Index System for Railway Operation Majors in Higher Vocational Education Based on SOLO Theory

Jie Li, Wei Wang*

Hunan Railway Professional Technology College, Zhuzhou, Hunan, China, 412001

*corresponding author

Keywords: SOLO theory, SEM, Vocational railway operation major, Course diagnosis

Abstract: This article combines SOLO theory to select indicators for the diagnosis of vocational railway operation professional courses, and identifies 6 first level indicators and 21 second level indicators that affect course diagnosis. Based on the reliability and validity results of the indicators, a structural equation model of vocational railway operation professional course diagnosis indicator system is constructed, and the model has good fitting. At the same time, this indicator system is used to diagnose the railway operation professional courses of Hunan Railway Vocational and Technical College, The diagnostic results are largely consistent with the evaluation of the theoretical course by relevant experts, indicating that the design of the diagnostic indicator system for this course is reasonable and has certain promotional significance.

1. Introduction

In recent years, China's railway industry is still in a period of rapid development, and information and intelligent railway operation technology and equipment are constantly being applied. As the core profession for cultivating talents in railway passenger, freight, and train operation positions, railway operation must keep up with the development and changes of industry enterprises. Curriculum is a key link in the generation of talent cultivation quality in vocational colleges, and also the core area of education and teaching reform[1]. However, curriculum diagnosis and improvement in higher vocational colleges are still in the initial, fragmentation and disordered stages, and the indicator system of curriculum diagnosis and improvement also lacks standardization, systematicness and long-term effectiveness[2]. Therefore, how to design a set of operational and adaptable curriculum diagnosis indicator system is helpful for better guiding curriculum diagnosis and improvement, improving the quality of curriculum teaching, and enhancing the level of professional talent cultivation, which has certain theoretical value and practical significance.

2. Theoretical Review

To ensure the steady improvement of the quality of railway operation professional courses, this article proposes to construct a diagnostic indicator system for vocational railway operation professional courses based on SOLO theory. The entire process of SOLO theory is the Structure of the Observed Learning Outcome, which translates to the structure of observable learning outcomes and was proposed by Australian scholar Biggs in the 1980s[3]. SOLO theory is commonly used as a learning evaluation method to promote teachers' understanding of the hierarchical structure of students' thinking during the learning process by discovering the quantity and quality of knowledge they possess[4,5]. Scholars such as Biggs have learned in practical research that students exhibit a continuous upward trend in their thinking levels based on different learning contents, and this trend is repeated in different learning fields, indicating that students repeatedly transition from beginners to experts during the learning process[6].

This article is based on the connotation of SOLO theory, combined with the relevant requirements of vocational railway operation courses, to define the ability levels of vocational

railway operation students. The first type is at the pre structural level, where students at this level have no grasp of the basic concepts and work laws of railway operation majors. The second type is the single structure level, where students at this level have a simple understanding of certain railway operation majors' individual concepts and cannot understand the connections between concepts. The third type is the level of diversified structure, at which students can understand the concepts of multiple railway operation majors and recognize the basic laws of railway operation work. The fourth type is the level of parallel structure, where students can integrate the concepts of multiple railway operation majors and fully understand and apply the knowledge and laws of railway operation work. The fifth type is to expand the level of structure, where students at this level can expand their knowledge of railway operations and timely think about solutions to complex problems[7-9]. Based on the SOLO theory, students' ability levels remind learners to actively understand the learning content and continuously improve their learning level when formulating learning plans and strategies, in order to achieve good learning outcomes[10]. Given the positive role of SOLO classification theory in evaluating students' learning situation, this article will use SOLO classification theory as a reference tool for course diagnosis. The schematic diagram of the ability levels of vocational railway operation students based on SOLO theory is as Figure 1.

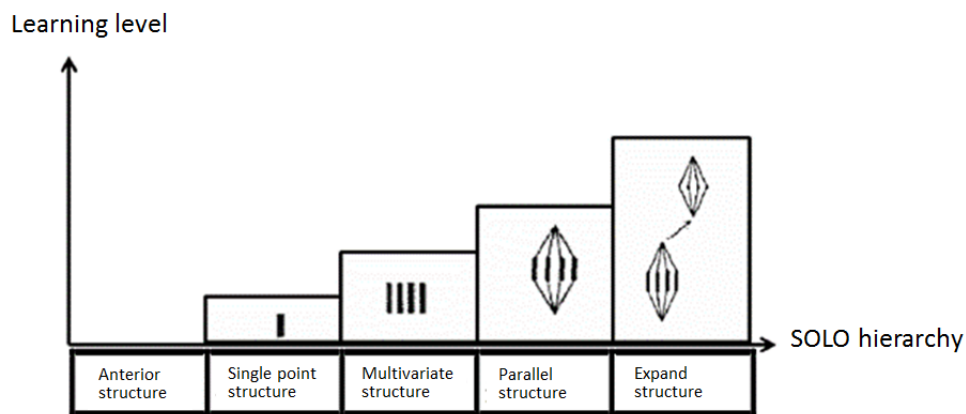


Figure 1 Schematic diagram of the ability levels of vocational railway operation students based on SOLO theory

3. Research on Diagnostic Indicators for Railway Operation Major Courses in Higher Vocational Education

3.1. Preliminary Selection of Diagnostic Indicators for Railway Operation Courses

In the early stage, by consulting a large amount of research materials on the curriculum diagnosis indicator system, this article extracted a series of relevant important information such as curriculum objectives, teaching staff, and textbook resources, as reference materials for constructing the curriculum diagnosis indicator system for vocational railway operation majors. At the same time, this article combines advanced cases of curriculum diagnosis and reform in vocational colleges across the country with the current status of curriculum diagnosis in vocational railway operation majors. Based on the SOLO classification theory, the selected diagnostic indicators have been modified and improved on the basis of several universal curriculum diagnosis indicator systems. After conducting a questionnaire survey with experts in the railway operation industry, professors in the railway operation major of vocational colleges, and full-time and part-time teachers, and listening to opinions and suggestions from various aspects, and through two rounds of verification discussions, combined with the curriculum requirements of the railway operation major in vocational colleges, the diagnostic indicator system for the railway operation professional course in vocational colleges has been revised and improved. The indicator system includes 6 first level indicators and 21 second level indicators, and the selection of indicators conforms to the principle of combining quantitative and qualitative analysis, and the SOLO classification theory is used as the

main screening basis. The diagnostic indicator system for vocational railway operation courses based on SOLO theory is shown in Table 1.

Table 1 A Course Diagnosis Index System for Railway Operation Majors in Higher Vocational Education Based on SOLO Theory

Primary indicators	Secondary indicators	Code name
Teaching objectives (JXMB)	Does the overall goal of the course meet the requirements of the learning ability level.	JXMB1
	Does the phased objectives of the course meet the requirements of the learning ability level.	JXMB2
	Does the course positioning meet the requirements of learning ability level.	JXMB3
Teaching staff (SZDW)	Does the teacher's educational structure meet the requirements for learning ability levels.	SZDW1
	Does the teacher's professional title meet the requirements for learning ability levels.	SZDW2
	Does the teacher's teaching experience meet the requirements of learning ability level.	SZDW3
	Does the teacher's literacy meet the requirements of learning ability level.	SZDW4
Teaching conditions (JXTJ)	Does the investment in teaching funds meet the requirements of learning ability level.	JXTJ1
	Does the course teaching documents meet the requirements of learning ability level.	JXTJ2
	Does the textbook and teaching aids meet the requirements of learning ability level.	JXTJ3
	Does the teaching and practical training equipment meet the requirements of learning ability level.	JXTJ4
Teaching process (JXGC)	Does the teaching content meet the requirements of learning ability level.	JXGC1
	Does the teaching method meet the requirements of learning ability level.	JXGC2
	Does the teaching assistance link meet the requirements of learning ability level.	JXGC3
Teaching management (JXGL)	Does the course assessment meet the learning ability level requirements.	JXGL1
	Does the course teaching system meet the requirements of learning ability level.	JXGL2
	Does teaching quality monitoring meet the requirements of learning ability levels.	JXGL3
	Does the teacher's teaching and research activities meet the requirements of learning ability level.	JXGL4
Teaching effectiveness (JXXG)	Does the student evaluation meet the requirements of the learning ability level.	JXXG1
	Does the quality of student training meet the requirements of learning ability levels.	JXXG2
	Does the student's innovative practical ability meet the requirements of the learning ability level.	JXXG3

3.2. Data Sources

This article screened and revised the diagnostic indicators for vocational railway operation courses by distributing questionnaires to over 400 experts engaged in teaching, course management, scientific research, and outstanding student representatives. The weights of each indicator in the diagnostic indicators were ultimately determined. Considering the complexity of the questionnaire content, the experts selected in this article were from frontline experts from various vocational

colleges in Hunan Province and abroad, and fill it out in combination with email and on-site interviews. The title of this questionnaire is "Expert Consultation Questionnaire on the Construction of the Diagnosis Indicator System for Railway Operation Majors in Vocational Colleges". The content of the questionnaire mainly includes the following parts: explanation of filling out the form, expert information, research purpose and significance, and evaluation of the importance of diagnostic indicators. After several rounds of revision and improvement, a total of 400 expert consultation questionnaires were distributed and 359 were collected.

3.3. Reliability and Validity Analysis

The diagnostic indicator system for railway operation courses in vocational colleges constructed in this article involves evaluating and scoring the importance of 6 first level indicators and 21 second level indicators. The importance is measured using the Likert 5-level scale, where "very important" is scored as 9 points, "relatively important" is scored as 7 points, "generally important" is scored as 5 points, "not very important" is scored as 3 points, and "very unimportant" is scored as 1 point. The factor analysis function of SPSS22.0 software was used to process the questionnaire data, and the results showed good performance. Among them, the KMO value of the sampling suitability test for the questionnaire was 0.885, which was between 0 and 1 and close to 1, indicating that the partial correlation coefficient between various indicators should be small and have good correlation. The data is suitable for factor analysis. At the same time, the Bartlett spherical test value of the questionnaire was 0.000, and the P-value of the test result was less than 0.05. The data of each indicator in the course diagnosis indicator system showed a spherical distribution, and the indicators were to some extent independent of each other. The reliability of the questionnaire was tested and the results were equally good. The overall Cronbach questionnaire α The coefficient value is 0.876, ranging from 0.70 to 0.98, which belongs to high reliability. The Cronbach coefficient between various indicators α and the coefficient values are all above 0.6, indicating good reliability and consistency of the questionnaire.

4. Diagnosis and Analysis of Higher Vocational Railway Operation Professional Curriculum Based on SEM

This article takes the curriculum of vocational railway operation as the research object, and analyzes the factors affecting the diagnosis of vocational railway operation curriculum. It can be seen that there is a correlation between the first level indicators. Using AMOS22.0, a second-order confirmatory factor analysis model of the vocational railway operation curriculum diagnosis system is drawn. The structural equation model of this indicator system is shown in Figure 2, the data was brought into the model for estimating the parameters of the structural equation model for the diagnostic indicators of vocational railway operation professional courses. After testing, the overall fit of the diagnostic model for this course was good, and the model's adaptability was good. The relevant data are shown in Tables 2 and 3, which belong to the ideal model.

Table 2 A Overall Goodness of fit index of diagnostic index system for railway operation courses in higher vocational colleges

Statistical inspection quantity	RMSEA	CMIN/DF	CFI	GFI	TLI	PGFI
Adaptation standards	<0.08	(1.3)	>0.9	>0.9	>0.9	>0.5
Measured value	0.064	2.186	0.936	0.907	0.927	0.703
Adapted or not	YES	YES	YES	YES	YES	YES

Table 3 Parameter estimation for diagnostic analysis of vocational railway operation courses based on SEM

Path coefficient	Estimate	S.E.	C.R.	P
JXMB ←--- Course diagnosis	1.000			
JXGC ←--- Course diagnosis	.806	.124	6.522	***
JXGL ←--- Course diagnosis	.674	.089	7.546	***
JXXG ←--- Course diagnosis	1.182	.116	10.149	***
SZDW ←--- Course diagnosis	1.059	.113	9.360	***
JXTJ ←--- Course diagnosis	.766	.101	7.559	***

Note: * represents significant at the 0.05 level, * * represents significant at the 0.01 level, and * * * represents significant at the 0.001 level.

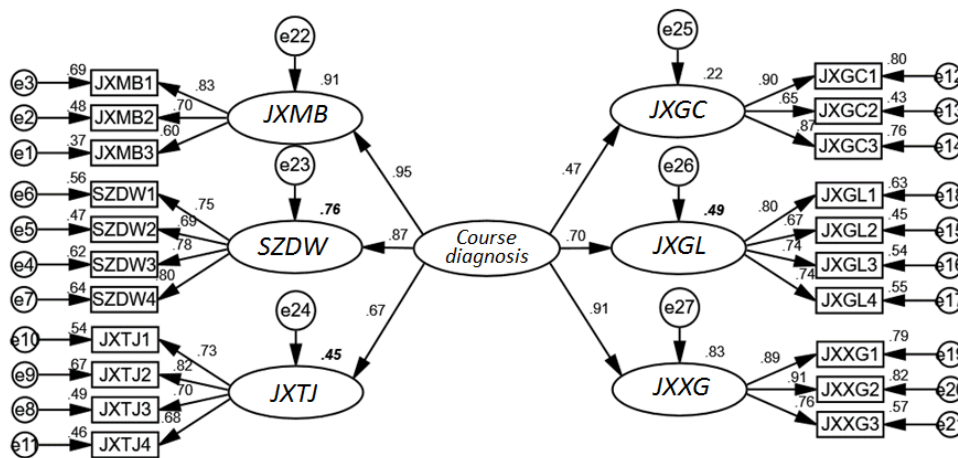


Figure 2 Structural Equation Model of Diagnostic Index System for Railway Operation Majors in Higher Vocational Education

The results in the table above show that the structural equation model of the diagnostic indicator system for vocational railway operation majors has a high degree of fit, with a RMSEA value of 0.064, < 0.08; The CMIN/DF values range from 1 to 3, and the GFI, CFI, and TLI values of the model are all greater than 0.9. All indicator values meet the significance test requirements. The weight of each indicator in the diagnostic indicator system of vocational railway operation professional courses has been calculated, and the results are shown in Table 4.

5. Case Analysis

In order to test whether the design of the diagnostic indicator system for railway operation courses in vocational colleges is reasonable and has good application functions, this article uses this course diagnostic indicator system to comprehensively diagnose the railway operation courses in a certain railway vocational college. More than 40 stakeholders of the railway operation courses in the school were distributed questionnaires for evaluation and scoring, and the final diagnostic results were good. However, based on the diagnosis of the courses in the school, The school still has some issues in certain aspects of its curriculum diagnosis system.

(1) The structure of the teaching staff is unreasonable. The age of recognized teachers in the vocational railway operation major curriculum of the school is middle-aged, with only 33% of teachers under the age of 40. (2) There are few curriculum teaching and research activities carried out. The teaching task of full-time and part-time teachers in vocational railway operation professional courses is heavy, and the contradiction between engineering and learning is prominent. Teachers do not attach enough importance to the construction of professional courses, and the school invests less research funds in vocational railway operation professional courses. Teachers

lack enthusiasm for course teaching and research. (3) Lack of teaching aids. Professional and part-time teachers of railway operation courses in vocational colleges have not conducted extracurricular tutoring activities and have not developed corresponding extracurricular tutoring plans. Teachers mainly focus on classroom activities for students' education, and do not carry out expansion activities to improve their ability levels. They do not pay attention to the ability improvement of students beyond 8 hours of extracurricular activities.

Feedback the diagnostic results to the academic affairs department of the school, and the other party reflects that it is in line with the actual situation of the school. The school will increase the improvement of the above issues in the next step of curriculum diagnosis and improvement process.

Table 4 The weight of the first and second level diagnostic indicator systems for vocational railway operation courses

Primary indicators	Route coefficient	Index weight	Secondary indicators	Code name	Index load	Index weight
Teaching objectives JXMB	0.95	0.208	Does the overall goal of the course meet the requirements of the learning ability level.	JXMB1	0.83	0.389
			Does the phased objectives of the course meet the requirements of the learning ability level.	JXMB2	0.70	0.328
			Does the course positioning meet the requirements of learning ability level.	JXMB3	0.60	0.281
Teaching staff SZDW	0.87	0.190	Does the teacher's educational structure meet the requirements for learning ability levels.	SZDW1	0.75	0.248
			Does the teacher's professional title meet the requirements for learning ability levels.	SZDW2	0.69	0.228
			Does the teacher's teaching experience meet the requirements of learning ability level.	SZDW3	0.78	0.258
			Does the teacher's literacy meet the requirements of learning ability level.	SZDW4	0.80	0.264
Teaching conditions JXTJ	0.67	0.147	Does the investment in teaching funds meet the requirements of learning ability level.	JXTJ1	0.73	0.249
			Does the course teaching documents meet the requirements of learning ability level.	JXTJ2	0.82	0.279
			Does the textbook and teaching aids meet the requirements of learning ability level.	JXTJ3	0.70	0.238
			Does the teaching and practical training equipment meet the requirements of learning ability level.	JXTJ4	0.68	0.232
Teaching process JXGC	0.47	0.103	Does the teaching content meet the requirements of learning ability level.	JXGC1	0.90	0.372
			Does the teaching method meet the requirements of learning ability level.	JXGC2	0.65	0.268
			Does the teaching assistance link meet the requirements of learning ability level.	JXGC3	0.87	0.359
Teaching management JXGL	0.7	0.153	Does the course assessment meet the learning ability level requirements.	JXGL1	0.80	0.271
			Does the course teaching system meet the requirements of learning ability level.	JXGL2	0.67	0.227
			Does teaching quality monitoring meet the requirements of learning ability levels.	JXGL3	0.74	0.251
			Does the teacher's teaching and research activities meet the requirements of learning ability level.	JXGL4	0.74	0.251
Teaching effectiveness JXXG	0.91	0.199	Does the student evaluation meet the requirements of the learning ability level.	JXXG1	0.89	0.347
			Does the quality of student training meet the requirements of learning ability levels.	JXXG2	0.91	0.355
			Does the student's innovative practical ability meet the requirements of the learning ability level.	JXXG3	0.76	0.296

6. Conclusions

This article combines SOLO theory to select indicators for the diagnosis of vocational railway operation professional courses, and identifies 6 first level indicators and 21 second level indicators that affect course diagnosis. Based on the reliability and validity results of the indicators, a structural equation model of vocational railway operation professional course diagnosis indicator system is constructed, and the model has good fitting. At the same time, this indicator system is used to diagnose the railway operation professional courses of Hunan Railway Vocational and Technical College. The diagnostic results are largely consistent with the evaluation of the theoretical course by relevant experts, indicating that the design of the diagnostic indicator system for this course is reasonable and has certain promotional significance. However, due to personal ability and resource issues, there are still some shortcomings in this article. For the diagnostic indicator system of railway operation majors in vocational colleges, the sample data selected during the screening of indicators is limited and insufficient to represent the national curriculum situation of railway operation majors. In future work, we will continue to increase attention to course diagnosis and enrich relevant knowledge, Optimize the diagnostic indicator system for railway operation courses in vocational colleges.

Acknowledgement

This paper was supported by a project from the foundation “Research on diagnosis and improvement of urban rail professional courses based on OBE concept” (XJK21BZJ031) and “Research on course diagnosis and improvement of Railway Operation Specialty based on SOLO theory – taking ‘Work of receiving and sending trains’ course as an example” (ZJGB2020023).

References

- [1] Hao Chao, Jiang Qingbin. On the Basic Connotation of Project Curriculum in Higher Vocational Education. *China Higher Education Research*, 2007, No.167 (07): 59-60.
- [2] Ma Guoqin. Research and Practice on the Teaching Model of Higher Vocational Courses Based on OBE Concept. *Vocational Education Forum*, 2020, 36 (05): 63-68.
- [3] Wu Weining, Zhu Xingjian. Research on Strategies for Academic Evaluation of High School Physics New Curriculum. *Physics Teachers*, 2008 (06): 4-6.
- [4] Li Yujun, Li Wen. Diagnostic Question Performance Level: From the Perspective of SOLO Classification Evaluation Theory. *Geography Teaching*, 2017 (09): 50-52.
- [5] John B. Biggs, Kevin F. Collins, Gao Lingbiao, and Zhang Hongyan. *Evaluation of Learning Quality*. Beijing: People's Education Press, 2011:214.
- [6] Wu Youchang, Gao Lingbiao. Application of SOLO classification method in teaching evaluation. *Journal of South China Normal University (Social Science Edition)*, 2008 (03): 95-99+160.
- [7] Wang Hongbo. *Research on the Application of SOLO Classification Theory in Middle School Physics Teaching*. Beijing Normal University, 2009.
- [8] Jiang Lijun. *A Study on the Evaluation and Practice of Cognitive Literacy in High School Geographic Regions Based on SOLO Classification Theory*. Sichuan Normal University, 2019.
- [9] Chen Shuizhen. *Diagnosis of Teaching Quality Based on SOLO Theory*. Fujian Normal University, 2018.
- [10] Li Chunyu. The advantages and disadvantages of the OLO classification evaluation method in student academic evaluation. *Teaching and Management*, 2013, 10:65-67.