Exploration of Higher Vocational Curriculum Reform in the Context of Production-education Integration: A Case Study of Mapgis Geologic Mapping

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Abstract. The production-education integration philosophy has exerted a profound influence on higher vocational education. Particularly, how to deepen the production-education integration during the actual education process has been widely concerned. Against this backdrop, this curriculum research team, in conjunction with 14 geological-related enterprises and institutions, implements the production-education integration project based on bilateral cooperation. With the Mapgis Geologic Mapping, the core course of geological specialty in higher vocational colleges, as an example, this curriculum research team conducts a comparative study and empirical analysis on the pilot reform of this course for partial classes. The practical results reveal that the production-education integration project curriculum benefits students' full mastery of curriculum knowledge and improvement of teaching satisfaction, albeit with an insignificant effect on improving the satisfaction of the "overall curriculum".

Keywords: Production-education Integration, Curriculum Reform, Geologic Mapping, Higher Vocational Colleges.

1 Introduction

Higher vocational education, serving as an integral component of higher education, aims to furnish high-quality technology, skills, and human capital for society. By cultivating diversified talents, it is conducive to promoting technological research and development (R&D), product upgrading, field technological changes, and the formation of service skills as well as lifelong learning in micro, small, and medium-sized enterprises (MSMEs). Hence, higher vocational education is regarded as an important engine for the high-quality development of the regional economy [1]. Overall, the school-running patterns of vocational education in various countries around the world present their respective advantages and characteristics [2].

In 2017, the General Office of the State Council officially issued the Several Opinions on Deepening the Production-education Integration, which pointed out that the primary objective of deepening the production-education integration is to pro-

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gressively enhance the participation of industry enterprises in running schools and improve the diversified school-running system, thereby fully implementing the school-enterprise collaborative education". On January 4, 2019, the Implementation Plan of National Vocational Education Reform released by the State Council distinctly proposed that it is imperative to "promote school-enterprise dual education featuring production-education integration". On May 1, 2022, the newly revised Vocational Education Law of the People's Republic of China, which was officially implemented, explicitly put forward the idea of adhering to school-enterprise cooperation based on production-education integration, promoting market-oriented employment, and strengthening the practice-oriented ability. Recently, the field of production-education integration has ushered in fruitful academic research results, with extensive scholars investigating the policy orientation, cooperation mechanism, and educational pattern [3, 4]. Nonetheless, the empirical research on curriculum construction and curriculum reform of production-education integration is still relatively limited.

2 Research Process and Methodology

2.1 Research Background

Yunnan Land and Resources Vocational College, where the author works, has been included in the first batch of modern apprenticeship pilot units in China. On the occasion of the end of the global COVID-19 pandemic, sophomores from four classes majoring in regional geological survey at Yunnan Land and Resources Vocational College began to practice the modern apprenticeship system. Specifically, the college contacted 14 enterprises and institutions for further cooperation through preliminary investigation and communication, whereas students voluntarily chose the internship units introduced by the school. Some students, assuredly, choose to stay in school and attend classes normally. Guided by the school, the secondary colleges, in cooperation with enterprises, jointly implement educational projects in the context of production-education integration. Meanwhile, with the support of school policies and funds, the College of Resources and Environment, together with a plurality of geological enterprises and institutions, undertakes teaching activities. In this context, the curriculum team of Mapgis Geologic Mapping, which is composed of the college and relevant enterprises, relies on this course to lead students to complete corresponding learning tasks and working projects jointly.

2.2 Grouping Experiment Design

Taking the sophomores majoring in regional geological survey in Yunnan Land and Resources Vocational College as the subject investigated, this research adopts the grouping experiment method to facilitate the teaching experiment, with the experimental period being one semester encompassing 17 weeks. Students are neither informed that their courses are conducted in grouping experiments during the teaching process, nor are they given any information about whether they belong to the experimental group or the control group during the semester teaching. These efforts are aimed at avoiding psychological hints to students, thereby ensuring the fairness of the experimental results. Specifically, regarding the subjects who are included in the control group, the traditional classroom teaching methods according to the chapters of the textbook will be utilized to teach them. In contrast, regarding the subjects who are included in the experimental group, the project courses jointly developed by the production-education integration project team will be used for their teaching, with both personnel from the school and enterprise being responsible for the teaching activities. Notably, the teaching contents of the two groups present the same main knowledge points and different teaching methods, as depicted in Table 1.

Table 1. Implementation Overview of Grouping Experiment

Group categories	Teaching contents	Lecturers	Teaching methods	Teaching places
Control group	Basic operating knowledge of Mapgis software and drawing skills in geological maps	School teachers	Classroom teaching without project courses	School classrooms
Experimental group	Basic operating knowledge of Mapgis software and drawing skills in geological maps	School teachers and enterprise masters	Project tasks formulated based on the project curriculum of production-education integration and as per the actual work demands of enterprises	School classrooms and enterprise offices

2.3 Project Curriculum Design

This curriculum team designs the course's teaching process according to the real drawing requirements of enterprises and institutions, in which the workflows of drawing geological plane graphs, measured profile maps, and borehole histograms are restored. Through repeated investigations of the curriculum content, the curriculum team formulates three primary projects and corresponding tasks. More precisely, the first project is the vectorization of topographic maps, which requires students to analyze topographic maps, divide layers in detail, and edit corresponding point, line, and surface files, respectively, thus completing the final map-making. Additionally, the second project is the collation of field data, which requires students to effectively process and analyze field mapping data, measured profile data, and drilling data, as well as determine the corresponding plotting scale. Lastly, the third project is the drawing of geological plane graphs, measured profile maps, and borehole histograms, which requires students to be able to process the field data results and complete the final map-making according to the national standard format. School teachers are primarily responsible for classroom organization and teaching, whereas enterprise masters are involved in project task formulation and assessment and acceptance, enabling students' learning achievements to be certified [5]. During the teaching process, not only can the learning progress be promoted based on the project tasks, but the relevant personnel from the college and enterprises are jointly responsible for the teaching activities. As far as students are concerned, this teaching pattern is obviously different from traditional teaching, which brings brand-new pressures and challenges.

2.4 Experimental Process and Data Collection

At the beginning of the semester, students from four parallel classes majoring in regional geological survey and mineral prospecting intend to learn Mapgis Geologic Mapping. Through preliminary investigation and communication, this college, in conjunction with 14 selected enterprises, jointly implements the school-running practice featuring modern apprenticeship during this semester. Through the two-way free selection between students and enterprises, a total of 102 students decided to go to relevant enterprises for apprenticeship-based study, whereas the remaining 108 students received teaching based on traditional teaching methods at school. Under the premise of fully respecting students' right to choose independently, this experiment ensures the randomness of the samples. During the first class at the beginning of the semester, the teacher distributed an online survey questionnaire to the students for pre-teaching measurement, aiming to determine the students' cognition of the curriculum content without receiving the lecture, with the questionnaire taking 3 to 4 minutes to fill in. In the ninth teaching week, the mid-term teaching test for students was conducted to investigate students' mastery of curriculum knowledge and teaching satisfaction, while the post-test was conducted at the end of the semester, as illustrated in Table 2.

Table 2. Experimental Process and Test Items

Test time	Beginning of the semester	Middle of the semester	End of the semester
Test items	1. Cognition of curriculum knowledge and skills	1. Cognition of curriculum knowledge and skills; 2. Teaching satisfaction	1. Cognition of curriculum knowledge and skills; 2. Teaching satisfaction

2.5 Questionnaire Design

Conceptually, Mapgis Geologic Mapping is defined as a highly practical course that combines Mapgis software with geological map drawing. With regard to the design of this course, referring to the working standards of geological surveyors and the national geological map drawing standards, this research has implemented preliminary investigation in enterprises and selected the 13th five-year plan textbook Computer Geologic Mapping for Geological Engineering and Technology major of higher vocational education in natural resources industry as the reference textbook according to students' learning situation, which is utilized as the main basis for curriculum setting. Furthermore, referring to a host of mainstream textbooks, this research systemically combs the main knowledge points of this course, which serve as the basis of further questionnaire design.

Apart from the students' basic situation, the questionnaire design employs the 5-point Likert scale, according to which five items encompassing "completely unfamiliar" to "completely familiar" are assigned scores ranging from 1 to 5, as are five items encompassing "very unsatisfactory" to "very satisfactory".as shown in Table 3.

Table 3. Questions and Numbers of Questionnaires Distributed to Students

Measured items	Questionnaire items
Students' basic situation	Q1 Student number
	Q2 Gender
Mastery of knowledge and skills	Q3 Whether you are familiar with frame generation and image correction
	Q4 Whether you are familiar with the point data editing of topographic maps
	Q5 Whether you are familiar with the line data editing of topographic maps
	Q6 Whether you are familiar with the plane data editing of topographic maps
	Q7 Whether you are familiar with the finishing and output of topographic maps
	Q8 Whether you are familiar with the processing of field mapping data
	Q9 Whether you are familiar with the processing of field measured profile data
	Q10 Whether you are familiar with the processing of field drilling data
	Q11 Whether you are familiar with the process of drawing geological maps with Mapgis
Teaching satisfaction	Q12 Whether you are satisfied with the teaching content
	Q13 Whether you are satisfied with the teaching methods
	Q14 Whether you are satisfied with the teaching of the teachers
	Q15 Overall satisfaction with this curriculum

3 Quantitative Analysis Results

Leveraging the experimental data of two groups of samples obtained through grouping experiments, SPSS software is employed to perform mean comparisons and independent-sample T-test on the data. Regarding the sample size, the total number of students from four classes is 210, of which 108 students are included in the control group, and the remaining 102 students are included in the experimental group. Questionnaires were distributed to students at the beginning, middle, and end of the semester, respectively. Notably, each of these three surveys collected 210 valid questionnaires, with the recovery rate reaching 100%. In this foundation, this research initially implemented descriptive statistical analysis as well as reliability and validity tests on the data. The results indicate that Cronbach's alpha coefficient used to measure the reliability of samples is 0.783, revealing a better reliability.

3.1 Sample Test at the Beginning of Semester

The first test at the beginning of the semester is primarily to examine students' mastery of knowledge without receiving lectures. Furthermore, "0" in the sample data indicates the control group, while "1" indicates the experimental group. As per the statistical grouping data, the mean score of students' related knowledge of Mapgis Geologic Mapping is close to 0. Subsequently, through the mean-value calculation of the experimental data of 9 questions from Q3 to Q11, it is evident that the mean scores of the experimental group and the control group are both 1.06. Particularly, the student's average score on the question "Q3 whether you are familiar with frame generation and image correction" is 1, with a standard deviation of 0, leading to the failure of the t value to be calculated. Furthermore, this research conducted an independent-sample T-test on other questions, with the results shown in Table 4.

As can be seen from Table 4, there is no significant difference in the sample mean between the experimental group and the control group. In other terms, prior to the experiment starting at the beginning of the semester, students of the two groups basically possessed no mastery of the relevant knowledge and content of *Mapgis Geologic Mapping*, exhibiting no difference between the two groups. It proves that the sample satisfies randomness and is convenient for the subsequent curriculum reform experiments.

Table 4. Results of Independent-sample T-test for Students' Mastery of Curriculum Knowledge at the Beginning of the Semester

		Levene test of variance equation		T-test of the mean equation			
		F	Sig.	t	df	Sig. (bilateral)	Mean difference
Q4	Assuming that the variance is equal	3.426	.072	-.918	208	.362	.031
	Assuming that the variance is not equal			-.922	198.423	.357	.031
Q5	Assuming that the variance is equal	2.345	.134	.746	208	.423	.015
	Assuming that the variance is not equal			.757	207.224	.418	.015
Q6	Assuming that the variance is equal	.656	.425	.386	208	.675	.006
	Assuming that the variance is not equal			.389	203.564	.672	.006
Q7	Assuming that the variance is equal	1.752	.187	.655	208	.525	.023
	Assuming that the variance is not equal			.654	207.145	.524	.023
Q8	Assuming that the variance is equal	4.876	.034	-1.087	208	.267	-.033
	Assuming that the variance is not equal			-1.089	178.457	.284	-.033
Q9	Assuming that the variance is equal	2.337	.128	.776	208	.439	.016
	Assuming that the variance is not equal			.769	206.765	.437	.016
Q10	Assuming that the variance is equal	0.013	.923	-.054	208	.946	-.002
	Assuming that the variance is not equal			-.054	207.371	.947	-.002
Q11	Assuming that the variance is equal	3.153	.065	.923	208	.356	-.032
	Assuming that the variance is not equal			.924	199.552	.360	-.032

3.2 Test Results for Students' Mastery of Curriculum Knowledge

3.2.1 Students' Mastery of Curriculum Knowledge in the Middle of the Semester.

Table 5. Results of Independent-sample T-test for Students' Mastery of Curriculum Knowledge in the Middle of the Semester

Questions	Sig.	Sig. (bilateral)
Q3 Frame generation and image correction	.011	.112
Q4 Point data editing of topographic maps	.006	.075
Q5 Line data editing of topographic maps	.632	.764
Q6 Plane data editing of topographic maps	.008	.067
Q7 Finishing and output of topographic maps	.000	.012*
Q8 Processing of field mapping data	.000	.000**
Q9 Processing of field measured profile data	.000	.000**
Q10 Processing of field drilling data	.000	.000**
Q11 Process of drawing geological maps with Mapgis	.013	.217

The questions within the questionnaire distributed to students in the middle of the semester are expressed by Q', as shown in Table 5. The test results reveal that the mean value data of the two groups of samples are higher than those at the beginning of the semester. Subsequently, the second independent-sample T-test is employed to judge whether there is any difference between groups. The relevant results indicate that four knowledge points in the nine data results measured by the questionnaire exhibit significant differences between groups, while the other five showcase insignificant differences.

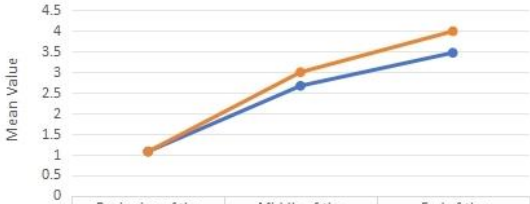
3.2.2 Students' Mastery of Curriculum Knowledge at the End of the Semester.

The questions within the questionnaire distributed to students at the end of the semester are expressed by Q", as outlined in Table 6. Among the nine curriculum knowledge points, there is no significant difference in the scores of students from the experimental group and the control group on the question "Q9 whether you are familiar with the processing of field measured profile data". By contrast, the significant differences between the two groups in students' mastery of the other eight knowledge points are observed.

Table 6. Results of Independent-sample T-test for Students' Mastery of Curriculum Knowledge at the End of the Semester

Questions	Sig.	Sig. (bilateral)
Q3 Frame generation and image correction	.011	.000***
Q4 Point data editing of topographic maps	.006	.000***
Q5 Line data editing of topographic maps	.632	.000***
Q6 Plane data editing of topographic maps	.000	.002*
Q7 Finishing and output of topographic maps	.053	.000***
Q8 Processing of field mapping data	.000	.000***
Q9 Processing of field measured profile data	.000	.000***
Q10 Processing of field drilling data	.000	.000***
Q11 Process of drawing geological maps with Mapgis	.689	.637

3.2.3 Variation Trend of Mean Value.



	Beginning of the Semester	Middle of the semester	End of the Semester
Mean Value of the Control Group	1.06	2.65	3.45
Mean Value of the Experimental Group	1.06	2.98	3.97

Fig. 1. Variation Trend of Students' Mastery of Curriculum Knowledge from the Beginning of the Semester to the End of the Semester

By investigating the data related to students at the beginning, middle, and end of the semester, this research further observed the data mean value of the two groups. Along with the advancement of learning, students' mastery of curriculum knowledge has ushered in significant improvement, with the mean value of the experimental group being higher than that of the control group. By summarizing the data of 9 questions from Q3 to Q11, this research ultimately calculated the mean value of the two groups, thereby implementing the corresponding variation trend analysis, as illustrated in Figure 1.

As can be seen from Figure 1, no difference between the two groups of data is observed at the beginning of the semester. As the curriculum teaching progressed, the mean value of the experimental group was progressively higher than that of the control group. By the end of the semester, the mean value of the experimental group was 15% higher than that of the control group, suggesting that the students in the experimental group were superior to those in the control group regarding their subjective cognition of curriculum knowledge. Combined with the results of the T-test, except the knowledge related to "the process of drawing geological maps with Mapgis", students' mastery of other knowledge points exhibits significant differences by the end of the semester.

3.3 Teaching Satisfaction Test Results

During the questionnaire survey on students' mastery of curriculum knowledge at the middle and end of the semester, this research conducted an anonymous teaching satisfaction assessment on students, which was divided into four dimensions. Subsequently, this research further analyzed the results of teaching satisfaction, as depicted in Table 7.

Based on the data concerning the changes in mean value, apart from the "teaching methods" in the middle of the semester, the mean value of satisfaction in the experimental group was slightly higher than that in the control group. Data from both groups showed an upward trend with the advancement of curriculum teaching, although the experimental group displayed a significant variation trend. Subsequently, the independent-sample T-test was conducted to further determine whether there were differences between groups. By combining the mean-value change in satisfaction with the observation data of p-value, it is found that the students in the control group are significantly more satisfied with the "teaching methods" in the middle of the semester than those in the experimental group. While the students in the experimental group exhibited a slightly higher mean value regarding satisfaction with "teaching content" and "teachers", there was no significant difference between the two groups. By the end of the semester, the differences between groups were observed in terms of satisfaction with "teaching content", "teaching methods", and "teachers". However, the student's satisfaction with the "overall curriculum content" has no statistically significant difference, whether in the middle of the semester or at the end of the semester.

Table 7. Changes in the Mean Value of Teaching Satisfaction

Group categories	Questionnaire content	Mean value in the middle of the semester	Mean value at the end of the semester
Control group	Satisfaction with the teaching content	3.92	3.96
	Satisfaction with the teaching methods	3.87	3.99
	Satisfaction with the teachers	3.78	4.45
	Satisfaction with the overall curriculum content	3.71	4.36
Experimental group	Satisfaction with the teaching content	3.93	4.17
	Satisfaction with the teaching methods	3.54	4.33
	Satisfaction with the teachers	3.88	4.86
	Satisfaction with the overall curriculum content	3.64	4.42

4 Research Results

On the one hand, the production-education integration curriculum is beneficial for students to master the knowledge of professional courses. The results of this research reveal that the mean value of students' subjective situation regarding the mastery of curriculum knowledge is gradually higher than that in the control group with the advancement of curriculum teaching. Particularly, eight of the nine vital curriculum knowledge points involved in the survey exhibit significant differences between groups. The knowledge point concerning "the process of drawing geological maps with Mapgis" serves as the only one with no obvious difference between groups. Being a basic framework for using Mapgis software to draw geological maps, it brings relatively limited difficulty for students to master. In short, it potentially contributes to the experimental results of this research.

On the other hand, the production-education integration curriculum is conducive to the improvement of teaching satisfaction, albeit with an insignificant effect on the overall satisfaction of the curriculum. In retrospect, the whole teaching process presents a relatively harmonious teaching relationship between teachers and students. Both teachers in the experimental group and the control group implement serious-minded teaching activities. The students, therefore, exhibit decent overall satisfaction. On the same note, the results demonstrate that the overall satisfaction of students with the curriculum may involve a relatively intricate influence mechanism, regardless of the certain influence exerted by the project curriculum on teaching satisfaction.

5 Conclusion

Taken together, the pilot reform enhances the confidence of the curriculum group to continue to promote the production-education integration project curriculum. Both the students' mastery of course content and their satisfaction with the course have improved.But the "overall" course satisfaction promotion effect is not obvious, the problems involved in the questionnaire is not detailed enough.In the future teaching and research, need to improve the specific implementation path of student satisfaction, ultimately improve students' satisfaction and sense of belonging.Through further reflection and revision, such a project curriculum pattern can be popularized within a wider range, such as through more classes and courses.

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