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Research on Relationship of Mathematical Literacy in Mathematics Curriculum Standards and Evaluation in Higher Vocational Education

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Abstract: *The relationship between higher vocational mathematics curriculum standards and core literacy is analyzed as it is of great significance for discussing the reform of higher vocational mathematics curricula for the cultivation of core literacy. The information resource data related to the curriculum standard is processed through the literature method and content analysis method. As a result, the existing mathematical classification and characteristics of higher vocational education are investigated with mathematical models. In the PSIA evaluation framework, the relationship between curriculum standards and mathematical literacy is evaluated and studied.*

Keywords: *Informational resources, Mathematical literacy, P ISA evaluation framework*

1. Introduction

The Ministry of Education stated cultivating highly skilled talents for production, construction, service, and management in Several Opinions on Improving the Teaching Quality of Higher Vocational Education in an All round Way. At present, teaching mathematics in higher vocational colleges focuses on theory rather than applications and lacks the support of innovative, scientific, and technological disciplines for talents. At the same time, the current mathematics curriculum in vocational colleges has problems in personalized learning, innovative thinking, integration of thinking, and politics. The establishment of a diversified and dynamic curriculum assessment and evaluation system is also a problem to solve.

2. Literature and Data

Taking HowNet data as an example, we screened the literature related to the curriculum standard and mathematical literacy to analyze and describe the data.

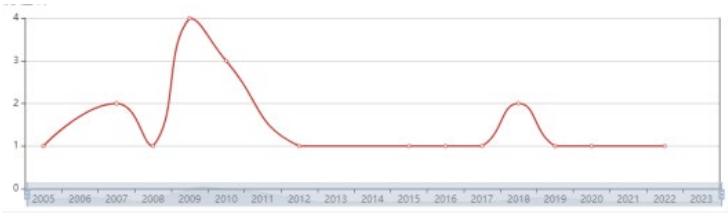

Figure 1: Annual number of relevant papers of higher vocational mathematics curriculum standard retrieved since 2005.

From figure 1 we can find a small peak of research in 2009 and 2010. The three common keywords with the highest frequency were "learning process, mathematics teaching, and curriculum standards". The keywords indicate that researchers attach great importance to the teaching and learning of higher vocational mathematics, and the formulation, improvement, and implementation of the curriculum standards require teaching links.

Figure 2 shows that in recent years, there has been an obvious upward trend in related topics, indicating that it is a relatively hot research issue. As early as the 1980s, China put forward the concept of "quality education". The concept represents the common attributes of the quality of various elements

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including basic physical elements such as physical movement and adaptation and psychological elements such as emotion, will, and values. Different quality elements affect people's activities in different aspects. In recent years, the hot issue of literacy research at home and abroad is the competency and competitiveness to successfully cope with or complete practical activities. Therefore, core quality corresponds to an actual activity that people are engaged in or that people have in the contemporary social context. For example, the qualities of independent action and interaction in social groups proposed by the OECD are specific to contemporary people. Quality element is the composition of core quality. Nowadays, subject-core literacy has become a hot issue in education and teaching research. As an important subject in basic disciplines, mathematics core literacy research attracts much attention.

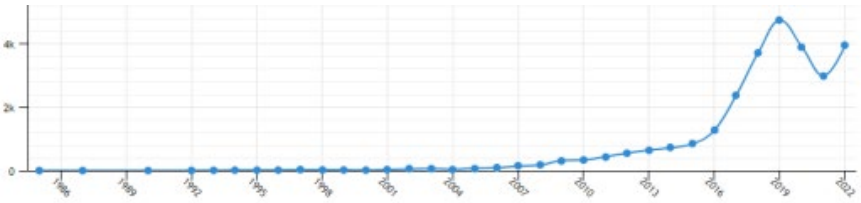

Figure 2: Annual trend of papers on mathematical core literacy retrieved since 2005.

Figure 3 shows the main theme of the literature. The distribution of main subject words shows the importance of mathematics in primary and secondary schools. Due to a large amount of data, there are no words related to higher vocational mathematics literacy in the top 20 subject words. However, vocational education ranks seventh among the disciplines, which shows that vocational education is related to mathematical literacy.

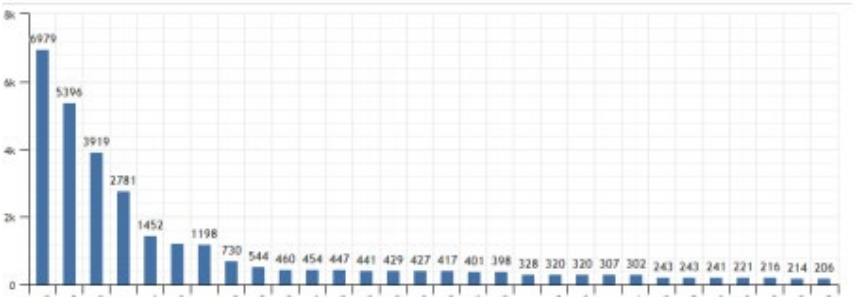

Figure 3: Distribution of main themes of literature.

Figures 4 and 5 show the distribution of research scope and disciplines in education and teaching. The top research institutions are mainly normal universities in various provinces and cities and comprehensive universities (Fig. 5).

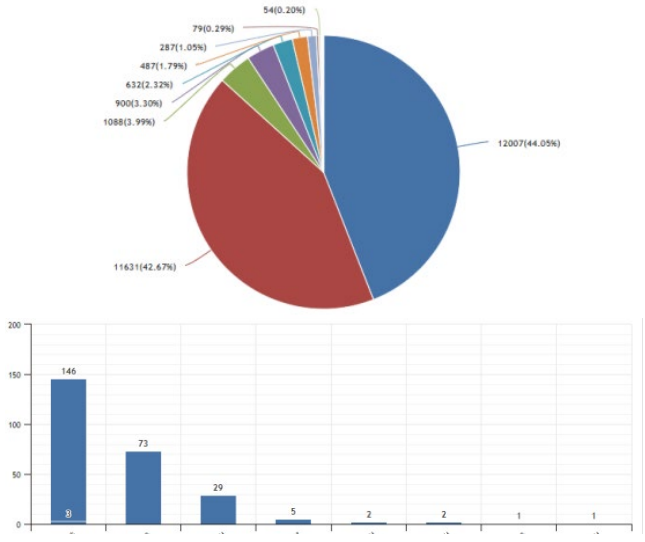

Figure 4: Chart of discipline distribution

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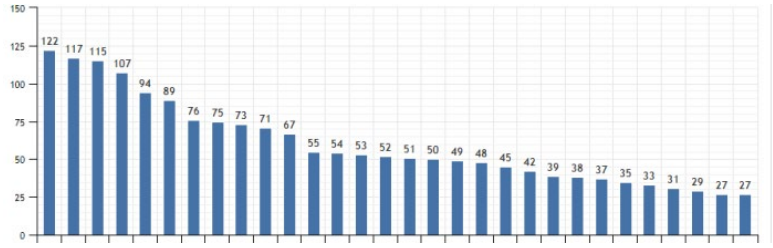

Figure 5: Distribution of literature authors' schools

3. Main Classifications

3.1 Focus on teaching content

Based on the "teaching content" and "higher vocational mathematics curriculum", Chen (2012) believed that higher mathematics needs to meet the needs of higher education and reflect the basic role and students' majors to serve them [2]. Wu (2018) believes that the modular teaching of mathematics is based on the principle of "taking the needs of the major as the standard". That is, different majors have different requirements for students' mathematical level. Therefore, the teaching content must be selected according to the specific requirements of the major to improve teaching efficiency and ensure that students complete all the necessary mathematical courses [3]. Since the principle of "necessary and sufficient" was put forward in the Basic Requirements for Higher Mathematics Teaching in Higher Vocational Education by the Ministry of Education, the reform of higher vocational mathematics teaching in China has been conducted to solve the problem of "necessary and sufficient" through modularization. For example, from the three modules of compulsory learning content+limited selective learning content+arbitrary selective learning content in basic, professional, and expansion modules, the teaching content is selected according to the specific requirements of the specialty.

3.2 Mathematical modeling

Because mathematics curriculum has the characteristics of abstraction, the problem of "emphasizing theoretical calculation and neglecting practical application" commonly exists in teaching in vocational colleges. There is a problem that the content does not reflect reality in the teaching process. The learning of higher mathematics is a continuous process. Most students in higher vocational colleges have a weak mathematical foundation at the middle school stage, which affects the follow-up learning of students and gives them the impression of "mathematics is difficult to learn". Integrating mathematical models into the curriculum reform enables students to apply mathematical knowledge, integrate theory with practice, establish a bridge between mathematics and practice, and enhance their awareness of using mathematical knowledge to deal with various complex problems in a practical and professional application. At the same time, the cited mathematical model must be simple and interesting, not demanding students' mathematical foundation. Students' interest in learning needs to be stimulated to improve mathematical literacy and arouse their interest in knowledge and desire for exploration.

3.3 Pay attention to combining specialties

Under the new situation, the employment of higher vocational students affects mathematics learning. The traditional hierarchical teaching based on students' mathematical foundation can no longer meet students' personalized learning needs. At Shandong Institute of Commerce and Technology, there are mainly two types of majors: business and engineering. In mathematics, different courses are built according to different majors, and professional courses are integrated into the curriculum. Thus, mathematics and professional courses are closely linked to lay a solid foundation for students to practice advanced development in the professional field. In addition, mathematical modeling courses are set up for students with a good mathematical foundation to solve the problem of "insufficiency" for top students in mathematics. Through the construction of the three curriculum systems, students with different needs choose courses according to their requirements to support different mathematical learning needs of students.

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3.4 Curriculum, ideology, and politics

The research on curriculum ideology and politics in domestic universities was formed in 2015 [1]. In combination with the query and practice of HowNet, Shanghai University took the lead in creating courses such as "the Strategy of a Big Country" and "Innovative China" in 2015 to innovate ideological and political education [2]. The purpose was to build an interdisciplinary ideological and political education platform, gather interdisciplinary high-quality teachers, and innovate the teaching methods of ideological and political education courses. In 2017, the Ministry of Education held the Shanghai Research Film Conference on the Teaching Quality of Ideological and Political Theory Courses in Colleges and Universities and the on-site promotion meeting of "Ideological and Political Courses" in colleges and universities to exchange the experience and practices of the reform of "Ideological and Political Courses" and the key measures of various regions to carry out the special work of "Ideological and Political Courses Teaching Quality Year". The experience of curriculum construction in Shanghai's colleges and universities was promoted at the event [3]. Since then, the study of ideological and political education has been started. The ideological and political education of curriculum is an important content and tool for the construction of micro-curriculum.

For modern teaching for curriculum development and construction in colleges and universities, the leading role of backbone teachers is to improve the quality of the main teachers and share the micro course resources. In the curriculum and the classroom, teaching effectiveness needs to improve. The construction of micro-course resources needs to reconstruct the course content, which plays an important innovative role in improving the teaching content and methods of higher mathematics courses and overcoming the difficulties in the construction of higher mathematics courses.

The Guiding Outline for Ideological and Political Construction of Courses in Colleges and Universities issued by the Ministry of Education pointed out that colleges and universities must deepen the reform of education and teaching, fully tap the ideological and political resources of various courses, give full play to the role of each course in educating people, and comprehensively improve the quality of talent training. In mathematics teaching, teachers need to integrate the origin, thought, development and culture of Chinese and Western mathematics into the basic knowledge of mathematics, weaken students' abstract basic theory learning, cultivate students' patriotism, and establish correct values. Through the accumulation of practical and professional applications, we can solve practical problems with mathematical modeling to guide students to find mathematical ideas and methods, improve their ability to solve problems with scientific methods and cultivate students' scientific thinking [4].

4. PISA Evaluation Based on Mathematical Literacy

In foreign research, the Program for International Students (Program for International Student Assessment, PISA) [8] has attracted the attention of mathematics education evaluators all over the world. The PISA assessment framework assesses students' literacy from three dimensions: content, process, and situation. The assessment of mathematical literacy in PISA2021 emphasizes the connotation of mathematical literacy [6], mathematical reasoning, and problem-solving. These are referred to our research on the evaluation of the core quality of mathematics. For example, Hu et al. pointed out based on the PISA evaluation framework and test question design [7] that in the evaluation of core literacy in mathematics, we need to pay attention to the practicality, scientificity, standardization, and guidance of the evaluation and accurately grasp the four elements of "literacy", "problem", "situation" and "knowledge". The intersection of theme and cognitive requirements describes the proportion of teaching content. The proportion of teaching content to total teaching time is used to make a content matrix. In order to better describe the consistency of teaching, evaluation, teaching materials, and curriculum standards, Pat constructed a consistency index to describe the matching degree between the ratio in one content matrix (description of evaluation) and another content matrix (description of standards) [6].

$$\text{Consistency index} \quad \mathrm{AI} = 1 - \frac{\sum |X - Y|}{2} \tag{1}$$

Where AI is the consistency index, X represents the ratio of the evaluation cell, Y represents the ratio of a standard cell, and its value is between 0−1 [9].

Mathematics teachers and researchers in higher vocational colleges participated in a questionnaire survey. The core quality of higher vocational mathematics is reflected in three aspects: increasing

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mathematical knowledge, solving practical problems, and cultivating mathematical thinking. The survey shows that the recognition of core literacy is relatively high and consistent. The consistency analysis is carried out to understand mathematical literacy such as mathematical calculation, data analysis, mathematical modeling and logical reasoning, and the three aspects of increasing mathematical knowledge, solving practical problems and cultivating mathematical thinking [5].

ANOVA analysis result shows that there is no significant difference among the three levels.

Table 1: Recognition of core quality of higher vocational mathematics discipline

Different levels	Very agree	identification	uncertain	Disagree	Very disagreeable
Increase mathematical knowledge	35%	55%	5%	3%	2%
Solve practical problems	36%	54%	4%	1%	5%
Cultivate mathematical thinking	37%	55%	5%	3%	0%

Table 2: Analysis of the direct consistency between the core quality of higher vocational mathematics and the improvement of mathematical ability

Core quality	Mathematical calculation	Data analysis	mathematical modeling	logical reasoning	….
Increase mathematical knowledge	0.53	0.49	0.23	0.22	….
Solve practical problems	0.18	0.54	0.78	0.25	….
Cultivate mathematical thinking	0.63	0.19	0.59	0.58	….

From Table 1 and Table 2, we can draw the following conclusions.Mathematical knowledge is the core quality of the mathematical discipline. Problem-solving is the concentrated expression of mathematical ability in mathematical knowledge transfer and application. Mathematical thinking is based on mathematical knowledge and problem-solving [9]. The three are independent and blended, which is an important component of the core quality of mathematics.

5. Conclusion

Building a powerful country in education is the goal of various educational reforms and development in the new era. Vocational education requires curriculum standards that conform to the characteristics of the times and educational laws. Higher vocational mathematics courses are also demanded. We need to pay attention to the quality construction of standards, focus on the core quality of disciplines, curriculum ideology, and teaching content, and attach importance to mathematical modeling and combining majors. At the same time, we need to carry out a scientific and standardized evaluation of the core quality.

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Research on the construction of high-quality double qualified teachers and teacher teams in higher vocational colleges 22JS0209, China Association of Higher Education.

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