

Analysis of the Research Status of High School Mathematics Teaching Design Based on BICOMB and SPSS

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Abstract: High school mathematics curriculum creates conditions for students' sustainable development and lifelong learning, and teaching design classroom starting point directly affects teaching quality and effect. In order to grasp the hot spots and trends in the research field of senior high school mathematics teaching design, this research uses BICOMB 2 and SPSS23, and HowNet collects 1298 key words related to effective documents of senior high school mathematics teaching design for visual analysis. The result shows that there are three areas in the research of senior high school mathematics teaching design: research on conceptual teaching design based on theoretical guidance, research on the integration and practice of mathematics teaching design, research on the integration of information technology support and traditional culture grasp teaching design. The research present situation presents the following four characteristics: The high school mathematics teaching design presents the trend of "whole individual whole"; The informationization of high school mathematics teaching design is in line with the development of the times; The support of high school mathematics teaching design seeks optimization; High school mathematics teaching design is close to humanism.

Key words: High school mathematics; Teaching design; Research status; Visual analysis

Introduction: High school mathematics curriculum is the main curriculum of ordinary senior middle schools after the compulsory education stage, which is fundamental, selective and developmental. Compulsory courses are open to all students to build a common foundation; Optional compulsory courses and elective courses fully consider the different growth needs of students, and provide a variety of courses for students to choose independently; High school mathematics curriculum creates conditions for sustainable development and lifelong learning of students. High school mathematics cultivates core literacy of students, and is the end of basic mathematics. Some high school contents involve knowledge of higher mathematics, which plays a connecting role in learning mathematics. The mathematics learning stage in senior high school is a critical period for students to establish complete mathematical thinking and perfect mathematical logic ability. Through the mathematical enlightenment in primary school and the establishment of basic mathematical thinking in middle school, students have the ability to use mathematical thinking to solve mathematical problems. Therefore, the research on high school mathematics has always been the focus of attention in the educational circle, and the discussion on high school mathematics has emerged in endlessly.

1. Data source and research process

1.1 Source

First, search for literature. Entering the advanced search interface of CNKI, we adopted the advanced search method. The subject was high school mathematics and included teaching design. The initial search time was uncertain, and the deadline was December 31, 2021. A total of 1312 articles were retrieved. To ensure the accuracy and effectiveness of the research, the research excluded articles unrelated to hot areas of integrated education, such as publication introduction, notice of solicitation, and meeting minutes, and 1298 effective research papers were obtained. An article often has only 3-5 key words, but it is the author's highly concise and summary of the article, which is the core of the article. Key words are the focus of literature research, building the development context and predicting the future development trend. This research adopts keyword research. First, standardize keywords, such as synonymous replacement of mathematical history and HPM, synonymous exchange of TCK and subject teaching knowledge; The core quality of the subject is revised to the core quality of mathematics; The combination of mathematical abstraction and mathematical abstract literacy, the combination of mathematical literacy and mathematical core literacy, and the combination of geometric sketchpad, GeoGebra, modern information technology and information technology; Key words interfering with research results such as senior high school biology and senior high school chemistry are excluded.

1.2 Research tools

The BICOMB 2 Bibliographic Item Co occurrence Matrix Builder, developed by Professor Cui Lei of the Department of Medical Informatics of China Medical University and Shenyang Hongsheng Computer Technology Co., Ltd., and SPSS 23 data statistical analysis software were used for data analysis. The BICOMB 2 software is used to extract keywords and merge, delete and replace them, so that they can be standardized and other document keyword statistics and word matrix generation. SPSS 23 is used for data clustering analysis and multidimensional scale analysis to finally draw the knowledge map of high school mathematics teaching design.

1.3 Research methods

This research relies on BICOMB 2 and SPSS 23, and adopts co word analysis, cluster analysis, multidimensional scale analysis and

literature research methods.

1.4 Research process

First, identify high-frequency keywords. BICOMB 2 was used to count the keywords of 1298 valid literatures. According to the calculated high-frequency keyword threshold, 32 keywords with frequency ≥ 16 were selected as high-frequency keywords. Second, generate high-frequency keyword discourse matrix. For the determined 32 high-frequency keywords, BICOMB 2 is used to generate high-frequency keyword discourse matrix. Third, cluster analysis. SPSS 23 is used to cluster the discourse matrix and generate a clustering tree and a high-frequency keyword Ochiai coefficient approximation matrix. Fourth, combined with the clustering results, the multi-dimensional scale analysis was carried out to draw the multi-dimensional scale knowledge map of domestic senior high school mathematics teaching design. Fifthly, combining the clustering results and knowledge maps, the author analyzes and discusses the domestic senior high school mathematics teaching design.

2. Research results and analysis

2.1 Statistics and Analysis of High Frequency Keywords in High School Mathematics Teaching Design

Use Bicomb statistics to extract keywords, including 2235 keywords with a total frequency of 3687. According to the second method introduced by Professor Guo Wenbin, the second method is to intercept about 40% of the total cumulative frequency keywords as high-frequency keywords. In this study, keywords were extracted through Bicomb statistics. It was found that the frequency of keywords with a total frequency of about 40% was 16. Therefore, keywords with frequency greater than or equal to 16 are selected as high-frequency keywords. See Table 1 for the results.

Table 1 High School Mathematics and Teaching Design Keyword Statistics

Serial number	Key words	Number	Serial number	Key words	Number	Serial number	Key words	Number
1	High school Mathematics	338	12	Research on teaching	34	23	Culture of Mathematics	20
2	Design of teaching	268	13	Core Qualities	33	24	Concept of function	20
3	Teaching Strategies	122	14	Information Technology	29	25	Function of trigonometry	20
4	Core literacy of Mathematics	118	15	Teaching in Class	28	26	Mathematical modeling	18
5	Teaching mathematics	67	16	High school students	28	27	Practice of teaching	18
6	History of Mathematics	50	17	Flipped classroom	28	28	Deep learning	17
7	Mode of teaching	44	18	Unit teaching design	24	29	Mind map	16
8	Conic curve	38	19	Mathematical concepts	24	30	Variable teaching	16
9	Teaching of concepts	36	20	Mathematical abstract literacy	24	31	High school	16
10	teaching	34	21	function	22	32	Mathematics subject teaching knowledge	16
11	Theory of APOS	34	22	Practice research	22	Total		1622

It can be seen from Table 1 that the total frequency of 32 keywords is 1624, accounting for 44.32% of the total frequency, among which the top 12 keywords are more than 33, including high school mathematics (338 times), teaching design (268 times), teaching strategies (122 times), mathematics core literacy (118 times), mathematics teaching (67 times), mathematics history (50 times), teaching mode (44 times), conic curve (38 times), concept teaching (36 times), APOS theory (34 times), teaching research (34 times), Teaching (34 times), other keywords are greater than 15. According to the keyword statistics, it preliminarily shows that the integration of mathematics core literacy, teaching strategies, mathematics history, and teaching models is still a hot issue in the research of senior high school mathematics teaching design in China. The least keywords such as mind mapping, variant teaching, and mathematics teaching knowledge have also been 16 times, indicating that these aspects have also been involved, the research has a certain depth, and researchers have paid attention to them.

2.2 High frequency keyword Ochiai coefficient similarity matrix and analysis of high school mathematics teaching design

The above 32 high-frequency keywords were analyzed by Bicom and imported into SPSS23. Ochiai coefficients were selected to transform them into a 32 X 32 similarity matrix. When analyzing the similarity of the Ochiai coefficient of high-frequency keywords, the number in the similarity matrix indicates the similarity between the data. The closer the number is to 1, the closer the distance between the two keywords is, the greater the similarity is; On the contrary, the greater the distance between keywords, the smaller the similarity. See Table 2 for details.

Table 2 High frequency keyword Ochiai coefficient matrix (part)

	High school Mathematics	Design of teaching	Teaching Strategies	Core literacy of Mathematics	Teaching mathematics	History of Mathematics	Mode of teaching
High school Mathematics	1.000	0.500	0.296	0.294	0.241	0.188	0.252
Design of teaching	0.500	1.000	0.285	0.282	0.229	0.205	0.095
Teaching Strategies	0.296	0.285	1.000	0.196	0.094	0.095	0.088
Core literacy of Mathematics	0.294	0.282	0.196	1.000	0.122	0.014	0.076
Teaching mathematics	0.241	0.229	0.094	0.122	1.000	0.111	0.120
History of Mathematics	0.188	0.205	0.095	0.014	0.111	1.000	0.046
Mode of teaching	0.252	0.095	0.088	0.076	0.120	0.046	1.000

From Table 2, it is obvious that the order of the distance between each keyword and senior high school mathematics is: instructional design (0.500), instructional strategy (0.296), mathematical core literacy (0.294), instructional model (0.252), mathematical teaching (0.241), mathematical history (0.188)... It reveals that senior high school mathematics is most closely related to instructional design; Senior high school mathematics is closely related to teaching strategies and mathematics core quality; Mathematics in senior high school is relatively loose with mathematics teaching and mathematics model; Relatively speaking, the combination of high school mathematics and mathematical history is the most loose. The results preliminarily show that most of the published literatures combine high school mathematics with instructional design for research, which shows that the instructional design of high school mathematics needs to be innovated urgently and hopes to achieve a breakthrough in traditional education. In the research of senior high school mathematics teaching design, we should not only pay attention to the main research objects such as teaching strategies, mathematics core literacy and teaching models, but also strengthen the research on the middle view elements such as mathematics history and mathematics teaching in senior high school mathematics teaching design.

3. The current situation of research on senior high school mathematics teaching design

Through the statistical analysis of the literature in the field of senior high school mathematics teaching design, it is found that the hot research fields in the field of senior high school mathematics teaching design in China have the following characteristics: senior high school mathematics teaching design presents the trend of "whole individual whole"; The informatization of high school mathematics teaching design is in line with the development of the times; The support of high school mathematics teaching design seeks optimization; High school mathematics teaching design is close to humanism.

3.1 The Informatization of Mathematics Teaching Design in Senior High School Corresponds to the Development of the Times

The application of modern information technology is one of the symbols of a new round of curriculum reform in China. The rational selection of media is an important link in teaching design. How to effectively use information technology to promote understanding of students of mathematical concepts, improve teaching methods, and promote the transformation of students' learning methods of students is also an important perspective of the study of "effective mathematics teaching". Provincial education administrative departments actively explore the excellent experience of interdisciplinary teaching supported by information technology in primary and secondary schools in areas where conditions permit, form demonstration cases, and build training resources and demonstration schools for local teachers to improve their interdisciplinary teaching ability. Integrate multiple resources such as colleges and universities, teaching and research institutions, teacher training institutions, and off campus science and technology activity center enterprises, organize training teams, and carry out interdisciplinary teaching training supported by information technology. Through the implementation of special training and the organization of multidisciplinary teaching and research activities coordinated by multiple schools, we will create a group of backbone teachers who carry out interdisciplinary teaching based on information technology, promote the innovation of information education and teaching, and comprehensively improve the core quality of students. Information technology in Figure 2 is domain 2, including five

keywords:senior high school students,function concept,information technology,mathematical culture,and mathematical teaching.It shows that information technology has its advantages in guiding mathematics teaching,and at the same time,it is integrated with mathematics culture.Part of domestic mathematics culture comes from traditional culture.The integration of information technology,teaching design and mathematics culture is helpful to enhance cultural self-confidence of students .At the same time,information technology,such as geometric sketchpad,GeoGebra,multimedia and other auxiliary teaching,makes geometry visible,improves teaching effect and optimizes teaching strategies.

3.2 Seeking the Optimization of the Scaffold in High School Mathematics Teaching Design

In the new era,high school mathematics teachers are required to correct incorrect teaching strategies,be good at innovating effective teaching strategies,and let students participate in mathematics classroom learning with strong interest,so as to help improve the effectiveness of mathematics teaching.Good teaching design has carried out reform and innovation in high school mathematics education on the basis of promoting and cultivating students'professional knowledge.The teaching design gives full play to the influence of mathematics education on students'comprehensive quality,laying a solid foundation for the cultivation of outstanding talents in China.Field 1 in Figure 2 is the teaching design research based on concept and theory guidance,including seven keywords:concept teaching,APOS theory,teaching research,mathematical concept,mathematical abstraction,function,and variable teaching.The so-called scaffolding of instructional design is the support of theory,and excellent support of instructional theory is conducive to creating excellent instructional design.Key words in the field,such as APOS theory,also include the theory of mathematical history,TEAM education theory integrating information technology,TPACK theory,etc.,which reflect its advantages in guiding teaching design.At the same time,variable teaching also injects new vitality and vitality into teaching design,which also shows that the framework of teaching design is constantly optimized and gradually forms a new teaching design style.

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