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The Research Hot Topics of *The Physics Teacher* in the Recent Five Years

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Abstract

This research uses BICOMB, UCINET and other bibliometric analysis software to extract keywords, statistically and visually analyze the 1463 articles of *The Physics Teacher* in the past five years, and obtains its research hotspots and directions in the past five years and obtains some enlightenment from it. Among them, the main research hotspots of physics teaching are teaching, physics teaching aids, educational evaluation, Newtonian mechanics, physics experiment, education policy and management, learning mode, electromagnetics, student development, physics history, kinematics, geometric optics, etc.

Subject Areas

Educational Reform

Keywords

The Physics Teacher, Physics Teaching, Research Hotspots

1. Introduction

Timely understanding of the context and dynamics of research on physics teaching in middle schools in China can provide new perspectives for such academic research [1]. Focusing on international physics teaching hotspots can absorb outstanding foreign research results, enhance international perspectives, and promote teaching reform and innovation. The article "40 Years of Middle School Physics Teaching Research: Core Themes and Evolution Trends—Based on the Visual Analysis of 12173 Papers in *The Physics Teacher* (*in Chinese*) from 1980 to 2020" in the core journal *The physics teacher* (*in Chinese*) in the

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field of physics education in China shows that since the establishment of *The Physics Teacher* (in Chinese), the research hotspots and core topics are mainly distributed in the fields of physics knowledge teaching, force and motion, electricity, physics experiment, electromagnetic induction, geometric optics, physics core literacy training and practice [1]. What are the research hotspots of *The Physics Teacher* as an international publication? Mastering the research hotspots of such publications can help us find a better direction in academic research. However, there are still few documents on this aspect in China. Therefore, this article uses bibliometric analysis software to analyze the results of *The Physics Teacher* in the past five years. Explore hot topics and get some inspiration from them, hoping to provide some help to physics educators.

2. Data and Methods

2.1. Data Source

The international publication *The Physics Teacher*, issued by the American Association of Physics Teacher (AAPT), was published in April 1963 and has been loved by many physicists. The authors set up an advanced search on CNKI as *The Physics Teacher* and published time from 2016.01.01-2021.3.13. The result was 1463 articles. Then export the searched literature results and manually delete invalid literature, and import the valid data into the BICOMB software [2] for keyword extraction, statistics and matrix generation.

2.2. Research Tools and Research Process

Knowledge graph is an important method that has emerged in the field of library and information science in recent years. It combines the theories and methods of applied mathematics, graphics, information visualization technology, information science and other disciplines with metrological citation analysis, co-occurrence analysis and other methods. Use the visual atlas to visually display the core structure, development history, frontier fields and overall knowledge structure of the research field [3]. This research uses BICOMB, UCINET and other software as the main research tools. First, the documents are exported from CNKI and imported into BICOMB software for basic statistical analysis, manual deletion of invalid documents, statistical ranking of keywords appearing in the documents, and high-frequency words with a word frequency greater than 20 as the main keywords. Secondly, import the generated co-occurrence matrix into UCINET software to obtain a high-frequency keyword network map, and generate a clustering theme map, so that the hot themes and directions of *The Physics Teacher* in the past five years can be seen intuitively and clearly.

3. Research Results

3.1. High-Frequency Keywords Obtained

After retrieval and statistics, a total of 2262 keywords were obtained. The keyword threshold is set to 20, and 72 high-frequency words with a word frequency

greater than 20 are counted, and the cumulative percentage is 56.16%. The statistical results of high-frequency words are shown in Table 1.

Table 1. Results of high-frequency words.

Serial number	Key field	Frequency of occurrence
1	Teaching	581
2	Educational aids	385
3	Education	367
4	Educational assessment	310
5	Educator	161
6	Physicists	139
7	Newtonian mechanics	127
8	News and events	113
9	Careers and professions	106
10	Books	97
11	Lectures	96
12	Scholarly publishing	95
13	Measuring instruments	90
14	Chemical elements	86
15	Laboratories	82
16	Public policy and governance	73
17	Universities	72
18	Journal	69
19	Polymers	63
20	Batteries	58
21	Rotational dynamics	57
22	Funding	51
23	Energy conservation	50
24	Musical instruments	47
25	Learning and learning models	47
26	Friction	46
27	Electromagnetism	44
28	Students	44
29	History of science	42
30	Abstracts	41
31	Free-body diagrams	40
32	Visual system	39
33	Transition metals	38
34	Gravitational force	37

Continued

35	Outreach	37
36	Electrostatics	36
37	Lenses	34
38	Optical imaging	34
39	Scientific society and organization	34
40	Kinematics	32
41	General physics	30
42	Microphones	29
43	Interviews	29
44	Electrical circuits	27
45	Conference	26
46	General relativity	25
47	Special relativity	25
48	Leptons	25
49	Astronomers	24
50	Thermal instruments	24
51	Awards and Prizes	24
52	Text books	24
53	Magnetic equipment	24
54	Programming languages	24
55	Sensors	24
56	Corrections	24
57	Fundamental constants	23
58	Internet	23
59	Electrodynamics	23
60	Telecommunications engineering	23
61	Diversity in science	22
62	Buoyancy	22
63	Magnetic fields	22
64	Geometrical optics	22
65	Data acquisition	22
66	Regression analysis	21
67	National Aeronautics and Space Administration	21
68	Thermodynamic states and processes	21
69	Geodesy	20
70	Classical mechanics	20
71	Speed of sound	20
72	Oscilloscopes	20

3.2. Building a Social Network and Clustering Map of High-Frequency Words

In the high-frequency word social network graph, the position of each node represents a different keyword, the connection between the keywords represents its internal connection, the size of the node represents centrality, and the larger the node, the more central [4]. The authors imported the high-frequency word co-occurrence matrix obtained by BICOMB software into the UCINET software, and generated the high-frequency word social network graph according to the parameters such as the centrality of the keywords, the position and the mutual relationship in the network graph, and then performed k-aggregation. The clustering map is obtained by class analysis, as shown in **Figure 1**. The larger the label in the figure, the stronger the keyword centrality and the higher the frequency of co-occurrence. Different label colors represent different clusters.

The high-frequency word network diagram shown in **Figure 1** shows the research hotspots of different clusters. The larger the label of the same color, the more relevant research on the topic. It can be seen from **Figure 1** that the research clusters of *The Physics Teacher* in the past five years are mainly distributed in physics teaching, physics education technology, general physics, and physics discussion. Among them, the research hotspots related to middle school physics teaching in these clusters mainly include: teaching, physics teaching aids, educational evaluation, Newtonian mechanics, physics experiments, educational

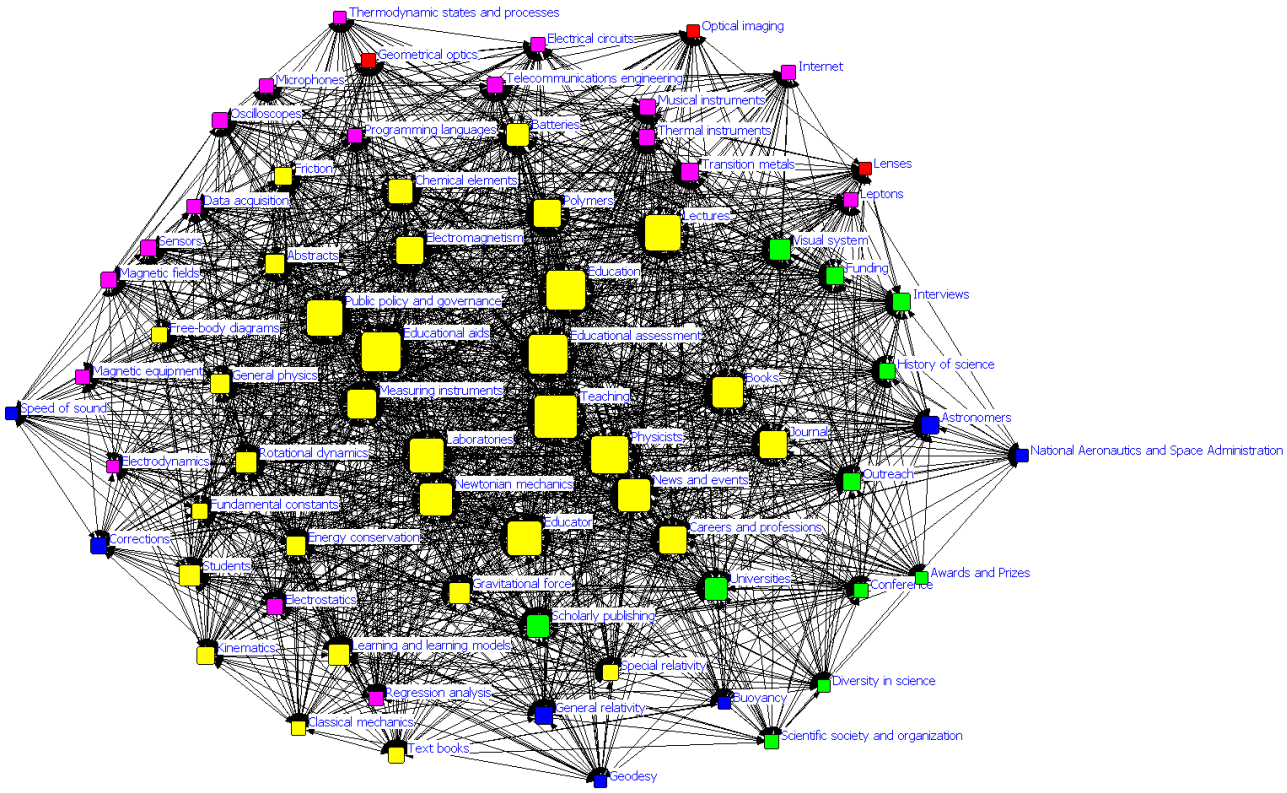

Figure 1. High-frequency word social network and clustering map.

policies and management, learning modes, electromagnetics, student development, physics history, sports Science, geometric optics, etc. The marginal areas of the map, such as the Internet, textbook analysis, and other relatively low-frequency words, reflect the trend of future research to a certain extent, and may become new hotspots and cutting-edge trends in physics teaching research.

4. Discussion of Results

4.1. Summary

The research hotspots of The Physics Teacher in middle school physics teaching mainly include teaching [5], physics teaching aids [6], educational evaluation [7], Newtonian mechanics [8], physics experiments [9], education policy and management [10], Learning Mode [11], Electromagnetism [12], Student Development [13], History of Physics [14], Kinematics [15], Geometric Optics [16], etc.

4.2. Comparison with the Core Themes of Middle School Physics Teaching Research of *The Physics Teacher* (*in Chinese*)

The research found that the sample literature of middle school physics teaching research presents the characteristics of wide research fields and prominent research topics. The research hotspots and core themes are mainly distributed in physics knowledge teaching, force and motion, electricity, physics experiments, electromagnetic induction, geometric optics and physics Discipline core literacy cultivation practice and other fields [1].

Compared with *The Physics Teacher* (*in Chinese*), *The Physics Teacher* pays more attention to research in the fields of student development, physics history and physics teaching aids, which reflects the difference between Chinese and international physics education to a certain extent. The 2005-2014 research shows that there is a big difference between Chinese and international physics education hot issues.

First of all, physics education in China has uneven performance in various hotspots of international physics education. Second, physics education and the development of physics cognition are not highly integrated. Third, physics education has obviously less research on student differences [17]. This is consistent with the results of this research, but it is not difficult to find that the research on physics education in China is moving closer to the research on international physics education.

After the promulgation of the 2017 version of the curriculum standard, all aspects of physics education in China have developed rapidly, with particular emphasis on the development of the core literacy of students in physics, which corresponds to the hot spots of student development in *The Physics Teacher*, while other fields such as student diversity, The penetration of the history of physics and the combination of information technology and education can also provide ideas and ideas for the development of physics education in China.

Students are the protagonists of learning, and teaching must conform to the cognitive development of students. More in-depth research on the cognitive development of students' physics is a necessity and prerequisite for doing a good job in physics teaching. The diversity of students has always been a problem that people are very concerned about in teaching. The "Teaching students in accordance with their aptitude" mentioned by Confucius was first born due to the differences of students, but in physics education research in China research, we rarely meet each other. If we want to improve the national physics education level, we must conduct in-depth research on the differences of students.

Infiltrating the history of physics into physics education and teaching is also an effective supplement and important resource for physics teaching. Teachers make reasonable use of the history of physics in teaching to help students establish a correct scientific outlook, stimulate their learning interest and learning emotions, and promote students to transform from passive learning to active learning, thereby improving the effectiveness of classroom teaching and cultivating students' scientific literacy [18].

With the development of the times, science and technology are becoming more and more developed, and the conditions for the development of physics education in China are getting better and better. The application of information technology, especially multimedia technology, in physics education is extremely important. Modern information technology with multimedia, networking, and intelligence as its main characteristics is having a profound impact and transformational effect on traditional curriculum concepts, curriculum content, curriculum implementation and curriculum resources [19]. Keeping up with the pace of the times, making full use of modern information technology and physics teaching to combine to continuously improve classroom efficiency, improve the level of physics education in China, and enhance the core literacy of students is our ultimate goal.

5. Enlightenment

For Chinese education sector, keeping abreast of international education research fields and hotspots and paying attention to the results of international physics teaching research is an important way to improve the level of physics education, promote the development of basic physics education and the professional development of teachers, and promote teaching reform and innovation. In recent years, although Chinese physics education pays more attention to the core literacy of the subject, in general, the research field is still narrow compared with foreign countries. In addition to the research on physics knowledge and subject core literacy, research in other fields such as the development of physics cognition, student differences, the history of physics, and the combination of modern information technology and physics education are all worth exploring and exploring.

For researchers and teachers in front-line teaching, grasping the current dif-

ferences between the current domestic and international physics education research hotspots can better start from the actual situation of physics education in China, combine first-line teaching to conduct more in-depth research and exploration, and constantly discover new problems and generate new thinking in the combination of research and teaching. For example, in the teaching process, teachers can effectively combine the history of physics with the content taught, or introduce the history of physics as a classroom throughout the classroom to make the ins and outs of knowledge clearer, stimulate students' interest in learning, consolidate knowledge, and improve teaching effect.

In 2013, the Ministry of Education initiated the revision of general high school curriculum. One of the basic principles of the revision work is to "adhere to reflect the requirements of the times", reflect advanced educational ideas and concepts, pay attention to the teaching reform in the information environment, and pay attention to the personalization and personalization of students. Diversified learning and development needs promote the transformation of talent training models and focus on the development of students' core literacy [20]. Curriculum revision work must not only integrate specific education situation in China, but also have an international perspective. The research hotspots of *The Physics Teacher* in the past five years drawn in this article are conducive to grasping the hotspots of international physics education, expanding international horizons, absorbing foreign excellent reform experience, and understanding educational trends in the information environment, such as learning models and student development etc. Perhaps it can provide a reference for the next revision of the curriculum standard and discover new developments in time. Continuously update and improve on the basis of inheritance, so as to establish a curriculum system with an international perspective and make it full of vitality.

Conflicts of Interest

The authors declare no conflicts of interest.

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