Advances in Economics, Business and Management Research, volume 49
2nd International Conference on Education, Management Science and Economics (ICEMSE 2017)

A Comparison of Knowledge Network in Junior Middle School Physics Textbooks between Chinese and American

—Take “Sound and Light” for an Example

Yu Chen
Normal College
Yanbian University
Yanji, China
yuchen327412@163.com

Corresponding author: Xue-mei Cui*
Normal College
Yanbian University
Yanji, China
xmcui@ybu.edu.cn

***Abstract*—Physics textbooks use physics terms to represent physics knowledge, and the network of knowledge formed by physics terms reflects its internal relation. For comparison purposes we present the “sound and light” part of the physics textbook of China and America on the knowledge network. We use complex network method to analyze the difference and similarity of knowledge networks. The results we obtained demonstrate that the closeness of the textbook knowledge in America is even higher. In our research, it is to be of great significance for providing a new way of comparing textbooks.**

Keywords—junior middle school; physics textbooks; knowledge network; complex network

I. Introduction

Physics education is the core part of junior middle school education both in China and America, so the physics textbooks play an important and basic role in curriculum resources for teaching. The textbook is of basis in terms of teachers teaching credentials, meanwhile, this is also the main tool for students to gain the knowledge. Therefore, the physics textbook quality together with classroom teaching eventually results in the whole teaching quality. From this view point, in comparison with the textbooks from China and America, this study is trying to provide some useful references for the writing structure of physics textbooks.

The research object of this study is “sound and light” part of the people's education press in the year of 2012 published *compulsory education physics textbook eighth-grade part* [1] and America junior high school teaching material *science explorer-Waves, Sound and Light* [2] that the Zhejiang education publishing published in the year of 2010.

Our analysis, consisting of both macroscopic level, the topic “sound and light” and its internal relations, and microscopic level, the method of complex network, to build the knowledge network, through the comparison of different knowledge network of two textbooks, reveals the characteristics and differences of these textbooks.

This research was supported by high education research project of Jilin association of higher education in 2016(Grant No. 2016[9]).

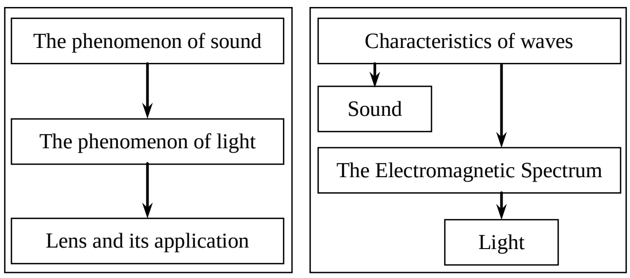
II. Sound and Light Theme and Its Internal Relation

In the theme of “sound and light”, the Chinese textbook is divided into 3 chapters, and the American textbook is divided into 4 chapters. Chinese and American textbook “sound and light” theme choreography is shown in Table I.

TABLE I. CHINESE AND AMERICAN TEXTBOOK “SOUND AND LIGHT” THEME CHOREOGRAPHY

The Chinese textbook	The American textbook
Chapter 2 The phenomenon of sound Chapter 4 The phenomenon of light Chapter 5 Lens and its application	Chapter 1 Characteristics of waves Chapter 2 Sound Chapter 3 The Electromagnetic Spectrum Chapter 4 Light

In the “sound and light” theme internal relationship, the Chinese one is obviously divided into two parts, but the American textbook starts from “wave” which makes the connection between chapters, as shown in Fig. 1.



(a) (b)

Fig. 1. The internal diagram of the “sound and light” theme of the textbook of China and America. (a)The textbook of China; (b)The textbook of America.

The analysis shows that the two textbooks under the same subject arrangement have differences and inherent relations. The Chinese textbook not only introduces light but also the application of light on lens, besides the Chinese textbook pays more attention to the depth of the knowledge. The America textbook uses the “wave” as the main idea and has a close contact between chapters, so the integration of American textbooks is better.

In order to present the characteristics of the physics textbook of China and America from a micro level, we use the complex network method to build the physics knowledge network, aiming to further exploration the characteristics of the textbook of the two countries.

III. THE CONSTRUCTION OF THE PHYSICS TEXTBOOK KNOWLEDGE NETWORK AND COMPARISON

A. Method of the physics knowledge network construction

Knowledge network referring to a kind of network reflects the relation between knowledge [3-6]. Knowledge network sets one knowledge unit as a node and takes the connection between knowledge units as the edge. To build the textbook knowledge network, our study regards physics terms as a node and makes an edge between physics terms in the same sentence at the same time. Construction of knowledge network specific way is shown in Fig. 2. The extraction of textbooks in physics terms with reference to *Oxford Dictionary of Physics with Chinese Translation* [7] and *Practical Physics Dictionary of Middle School Teachers* [8].

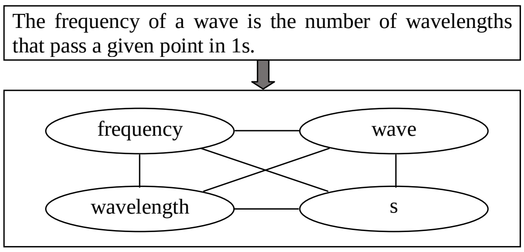


Fig. 2. Binary knowledge network construction method.

B. Statistical characteristics of physics terms

We define *f* to indicate the number of occurrences of each physics term. Table II lists 10 most frequent physics terms in 2 textbooks.

TABLE II. 10 MOST FREQUENT PHYSICS TERMS IN 2 TEXTBOOKS

Rank	China	*f*	America	*f*
1	light	88	wave	180
2	sound	77	sound	121
3	object	66	light	118
4	image	59	frequency	112
5	convex lens	45	object	105
6	vibration	30	sound wave	91
7	noise	25	ray of light	77
8	air	24	vibration	69
9	plane mirror	23	reflection	63
10	voice	23	energy	58

It is obvious that the physics terms of the textbook of China is significantly less than the one of America. But according to Table II, it can still be found these physics terms, such as, “voice”, “light” and “object” and “vibration”, whose frequency of utilization is relatively large in the textbook of China and America. It turns out that these physics terms play an important role in the content of “sound and light”.

Zipf’s law is a simple power-law distribution, discovered by linguists Zipf. When physics terms using frequency appear in descending order, there is a simple inverse relation between the word frequency and its rank. This distribution becomes Zipf’s law. In order to confirm whether physics terms comply with Zipf’s law, Fig. 3 lists the relation of frequency *f* and the number of occurrence *N*(*f*).

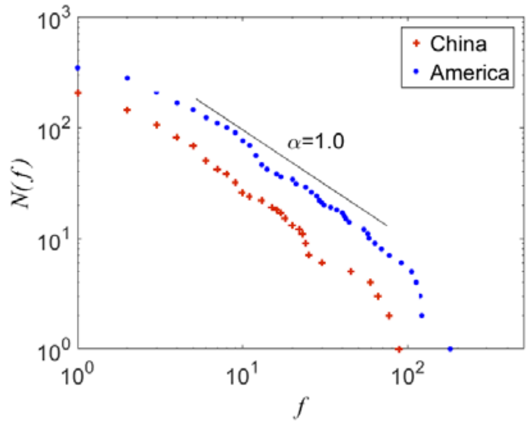


Fig. 3. Distribution of physics terms using frequency *f* for 2 textbooks. (log-log plot)

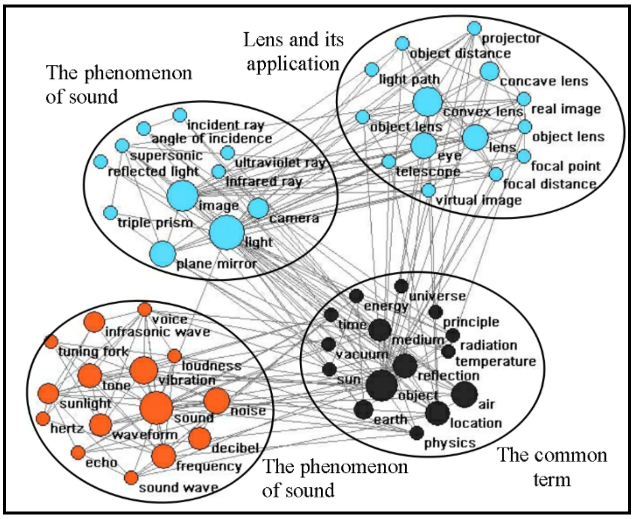
From Fig. 3, the distributions of the frequency of physics terms show a significant power-law distribution $N(f) \sim f^{-\alpha}$ and the index α of both Chinese and American textbooks is about 1.0, which means that Chinese and American textbooks have similar frequency characteristics of physics terms. In addition, the index obtained in this study is consistent with the conclusions made by other researchers about the frequency distribution of physics terms of physics textbooks. Therefore, the physics terms of 2 textbooks generally satisfy Zipf’s law. To sum up, the physics terms of 2 textbooks remain consistent at the micro level.

C. The comparison of physics knowledge network

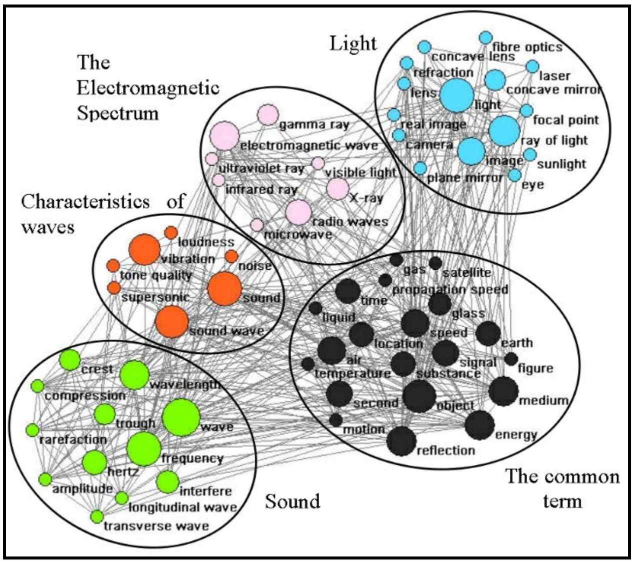
By means of Pajek [9] software and reference Table I theme, our study uses different color to classify physics terms, respectively and construct the junior middle school physics textbooks’ knowledge of binary network, as shown in Fig. 3. The common terms refer to the “sound and light” part, but not clearly belong to the relevant chapter. Due to the textbook of “sound and light” part of the contents of the different capacity, so the textbook of China selects physics terms whose frequency is 5 and above and the textbook of America select physics terms whose frequency is 6 and above.

Through comparing the physics knowledge network, we can find that knowledge network of the textbook of China physics even edge is less than the one of America. The mean degree of Chinese textbooks of physics knowledge network lays in $\langle D_{\text{China}}\rangle=8.37$, and the mean degree of American textbooks of physics knowledge network is $\langle D_{\text{America}}\rangle=14.55$, besides the textbook knowledge network of America closer ties between nodes.

On the arrangement of the theme, in the order of chapters' physics knowledge presented in the textbooks of China and America, and in accordance with, we show the progressive relation between physics knowledge. Fig. 4 shows that each chapter does not establish close contact in the textbooks of China, but the textbook of America links chapters through the basics "waves".



(a)



(b)

Fig. 4. Binary knowledge network of the theme of "sound and light". (a) The textbook of China; (b) The textbook of America.

On the theme of learning progressions, the part "sound" and "light" in the Chinese textbook between the basic does not undertake, and the part "voice, electromagnetic waves and light" is built on the basis of the "wave", and "can see electromagnetic wave is light", "electromagnetic waves" and "light" together in the American textbook. On scientific thinking, the depth of the Chinese textbook to improve some knowledge, such as the capacity of the chapter introduces the application of light, and embodies the "from life to physics, from physics to life" the curriculum concept. That the American textbook as a whole put all the knowledge closely linked reflects its focus on the internal-related knowledge.

IV. Conclusion

By macro level's the arrangement of "sound and light" part and their relations of comparison and analysis, this study has found the textbooks on the theme of "sound and light" arrangements and internal relations that exist differences; In order to reveal the difference of the textbook from micro level, our study construct the knowledge network of the physics textbook of China and America and has carried on the comparison and analysis, finding that the textbook physics presentation of knowledge network is different. It embodied in the contact between the tightness of each chapter, the theme of learning progressions and scientific thinking. This is the embodiment of the subject education concept differences between the two countries.

References

[1] X.-C. Peng, Compulsory Education Textbooks—Physics eighth grade. People's Education Press, Beijing, 2012. (In Chinese)

[2] M.J. Padilla, Science Explorer—Waves, Sound and Light. Liu and B.-Q. Fan Translation. Zhejiang education press, Hangzhou, 2010. (In Chinese)

[3] X.-M. Cui, F.Y. Li, and S.K. Han, "Analysis of the Characteristics of Physics Knowledge Network", J. Complex Systems and Complexity Science, vol.10, pp.30-36, June 2013. (In Chinese)

[4] X.-M. Cui, J.S. Jung and S.K. Han ,"Two-State Model of Word Occurrence in Physics Textbooks", New Physics, vol.66, pp.762-767, June 2016.

[5] X.-M. Cui, C.N. Yoon, J.S. Jung and S.K. Han, "A Study on the Interval Distribution of Terminology in Physics Textbooks", New Physics, vol.63, pp.648-654, June 2013.

[6] X.-M. Cui , S.K. Han and S. Zhang ,"Research on Knowledge Structure of Physics Textbook", International Conference on e-Education, e-Business and Information Management, Atlantis Press, pp.5-8,2014.

[7] I. Alan, Oxford Dictionary of Physics with Chinese Translation. L.-Q. Chen Translation. Shanghai Foreign Language Press, Shanghai, 2006. (In Chinese)

[8] Practical Physics Dictionary of Middle School Teachers Writing Group, Practical Physics Dictionary of Middle School Teachers. Beijing Science and Technology Press, Beijing, 1989. (In Chinese)

[9] V. Batagelj, A. Mrvar, Pajek: program for large networks analysis [DB/OL]. [2010-09-10]. http: //vlado.fmf.uni-lj.si/pub/networks/pajek/