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Analysis of a Typical Chinese High School Biology Textbook Using the AAAS Textbook Standards

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The purpose of this study was to evaluate a typical Chinese high school biology textbook using the textbook standards of the American Association for the Advancement of Science (AAAS). The data were composed of three chapters selected from the textbook. Each chapter was analyzed and rated using the AAAS textbook standards. Pearson correlations between the chapter ratings and the AAAS textbook standards were calculated. Results showed that the chapters meet most of the AAAS standards. This paper discussed the weaknesses and strengths of the textbook chapters based on the criteria. In general, the Chinese textbook was found satisfactory; however, there is still room for improvement. The study provides valuable insights and suggestions for improving the textbook.

Keywords: AAAS textbook standards, Chinese biology textbook, content analysis, correlation analysis

INTRODUCTION

For over half a century, textbooks have played a decisive role in teaching and learning activities. In today's classrooms, textbooks serve as primary teaching instruments (e.g., tool, tutor, guidebook and gauge) (Kulm, Roseman, & Treistman, 1999). "At all levels of schooling textbooks are often used as the primary organizer of the subject matter that students are expected to master and provide detailed explanations of topics to be taught" (Chiappetta & Fillman, 2007, p. 1847). Textbooks greatly influence how knowledge is delivered and communicated (Association for Supervision and Curriculum Development, 1997). With the development of the society, a majority of teachers use textbooks to guide their instruction (St. John, 2001). Around the world, teachers often use textbooks as their principal curriculum and source of lessons. They consider textbooks as manuals of instruction or standard books in any branch of study. Research shows

that it is common to use textbooks in teaching biology (Kuechle, 1995).

Literature Review

Within biology education, studies that analyze the textbooks are often found in national and international literature. In Turkey, biology textbooks are widely used in school. Çobanoğlu, Şahin and Karakaya (2009) write: "Textbooks are used for various reasons like reference sources and assignments as well" (p. 2505). In China, biology textbooks are the embodiment of the teaching reform and teaching research results (Wang, 2006). Chinese high school biology textbooks have an enormous influence on what is taught in high school biology classes and how it is taught (Lu & Liu, 2012).

Research on biology textbooks is especially significant in developed countries. In the USA, Roseman, Stern, and Koppal (2010) studied a method for analyzing the coherence of high school biology textbooks. "This work represents an important first step in meeting the need for methods to measure, characterize, and ultimately to improve textbook coherence" (p. 47). Chiappetta and Fillman (2007) analyzed five high school biology textbooks used in the USA for inclusion of the nature of science. They point out, "High school biology textbooks have played a

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State of the literature

- Textbook standards play a more and more important role in textbook compilation and evaluation.
- In comparative studies of different national textbook standards, Chinese curriculum standards have been found to be different from textbook standards of Western countries.
- The studies evaluated how well Chinese textbooks align with the AAAS textbook standards are rarely reported as relative work has been implemented in many other countries around the world.

Contribution of this paper to the literature

- This study focused mainly on analyzing a typical Chinese high school biology textbook using the AAAS textbook standards and finding out the weaknesses and strengths of the textbook.
- The findings of this study contribute to the implementation of the curriculum reform in China and improvement of Chinese teaching materials.
- The current study provides some valuable insights and suggestions for improving the Chinese biology textbook.

critical role in science education because most students enroll in this course and use the adopted textbook that is a central component of the curriculum” (p. 1848). In addition, Kesidou and Roseman (2002) examined nine middle school science textbook programs from a curricular perspective based, in part, on Project 2061. They propose that “New middle school science textbook programs that reflect the findings from learning research are needed to support teachers better in helping students learn key ideas in science” (p. 522). These studies can provide valuable experience and reference for other scholars.

Project 2061

Project 2061 is sponsored by AAAS. It is an AAAS long-term science education reform initiative to help all Americans have knowledge and skills in science, mathematics, and technology (Kulm, Roseman, & Treisman, 1999). Project 2061 supports an evaluation of textbooks for their match to benchmarks and standards. It provides a coherent set of K-12 learning goals that can be used in selecting and creating instructional materials. “The Project 2061 curriculum-analysis criteria are intended to address features of curriculum materials that are most important for teaching and learning for the large majority of students and teachers” (Kesidou & Roseman, 2002, p. 540). It reveals how well a textbook can support teachers in their efforts to help students learn specific ideas and

skills under the nationally accepted standards and benchmarks (Kulm, Roseman, & Treisman, 1999). “In essence, the Project 2061 evaluation procedure examines how well a material’s content aligns with each key idea selected and how well the instructional strategies in the student text and the teacher’s guide can support students’ learning of this content” (Stern & Roseman, 2004, p. 543).

Differences and Similarities between the AAAS and Chinese Textbook Standards

Chinese Ordinary High School Biology Curriculum Standards (hereinafter referred to as ‘curriculum standards’) were promulgated by the Ministry of Education of the People’s Republic of China in 2003 and put into use in the autumn of 2004 (Lu & Liu, 2012). Due to different cultures, the AAAS textbook standards and Chinese curriculum standards are quite different. The main differences between them are summarized in Table 1.

The AAAS textbook standards have indicators, but not have topics and activities. Each criterion of the standards is clarified by a brief explanation, a set of indicators, and a scoring scheme (e.g., excellent, satisfactory and poor), which can be used to judge how well the curriculum material meets the textbook standards. The AAAS textbook standards provide guidelines instead of specific textbook content. The standards do not include course objectives and textbook chapters. American textbooks are produced according to the demands of educational institutions. The textbook topics are organized by textbook publishers. The AAAS textbook standards lay out some principles for effective learning and teaching without biological specialized vocabulary and dense detail. The standards give priority to students. Most of the AAAS textbook standard indicators are closely related to the interests of students.

However, Chinese curriculum standards have topics and activities, but not have indicators. The standards include course objectives, content standards, and implementation suggestions. The Chinese curriculum standards look like a map to show how the textbooks organized. Chinese textbooks extremely focus on the standards. They are written based on the standards. Chinese textbooks match the standards very well. The standards articulate and connect fundamental ideas in biological science, including biological terms and detailed content material (e.g., experiments, activities, and examples). The standards give priority to the relationship between biology science, technology, and society. Chinese curriculum standards encourage students to understand the relationship between science, technology and society, as well as the relationship between human and nature.

Table 1. Differences between the AAAS textbook standards and Chinese curriculum standards

AAAS textbook standards:	Chinese curriculum standards:
<ul style="list-style-type: none"> • have indicators, but not have topics and activities. • do not include course objectives and textbook chapters. • provide guidelines instead of specific textbook content. American textbook topics are organized by textbook publishers. • lay out some principles for effective learning and teaching without biological specialized vocabulary and dense detail. • give priority to students. 	<ul style="list-style-type: none"> • have topics and activities, but not have indicators. • include course objectives, content standards and implementation suggestions. • look like a map to show how the textbook organized. Chinese textbooks very focus on the standards. They match the standards very well. • articulate and connect fundamental ideas in biological science, including biological terms and detailed content material. • give priority to the relationship between biology science, technology and society.

Table 2. Key ideas used for high school biology textbook evaluation

AAAS content	Chinese content
Cell Structure and Function	Molecules and Cells
Matter and Energy Transformations	Genetics and Evolution
Molecular Basis of Heredity	Steady State and Environment
Natural Selection and Evolution	Biotechnology Practice
	Biological Science and Society
	Modern Biological Technology Project

Key ideas used for biology textbook evaluation are different. According to the AAAS Project 2061, key science ideas used in evaluating high school biology textbook content alignment include Cell Structure and Function, Matter and Energy Transformations, Molecular Basis of Heredity, and Natural Selection and Evolution (AAAS, 1989; AAAS, 1993; National Research Council, 1996). However, Chinese content standards include three compulsory modules: Molecules and Cells, Genetics and Evolution, Steady State and Environment, and three elective modules: Biotechnology Practice, Biological Science and Society, Modern Biological Technology Project (Ministry of Education of the People's Republic of China, 2003) (see Table 2).

There are similarities between the AAAS textbook standards and Chinese curriculum standards. Both of them can be used as textbook evaluation criteria. The AAAS and Chinese textbook standards aim to improve the quality of teaching materials and enhance students' biological science literacy. They are close to real life and respect for the needs of the development of student diversity. They advocate inquiry-based learning and pay attention to cultivating students' innovative spirit and practical ability.

Purpose

The purpose of this study was to analyze a typical Chinese high school biology textbook using the AAAS textbook standards. This study is beneficial to the improvement of the typical Chinese biology textbook.

On the one hand, different cultural backgrounds effectively promote the cultural communication. On the other hand, knowing the alignment between educational material and textbook standards are good to monitor the implementation and effects of education reform. Chinese textbooks have not been evaluated using the AAAS textbook standards. However, such an evaluation can provide insights and suggestions for improving Chinese high school biology textbooks. For this purpose, the research asked how a typical Chinese high school biology textbook rates using the AAAS textbook standards. This study focused mainly on analyzing how well the Chinese biology textbook aligns with the AAAS textbook standards and finding out where the weaknesses and strengths of the textbook are.

METHOD

The current study was composed of two steps. Firstly, the document analysis of the Chinese ordinary high school biology curriculum standard experiment textbook published by people's education press was conducted. In doing so, the textbook was attentively read. Secondly, one by one careful examination was conducted. Each biology compulsory module was examined to evaluate whether the selected chapter meets the indicators of the AAAS textbook standards.

The Sample

At present, under the Ordinary High School Biology Curriculum Standards, there are five approved Chinese high school biology textbook versions (Lu & Liu, 2012)

that have minor differences, and each textbook is associated with a nationally approved summative examination. The five biology textbook versions are all written in strict accordance with the Chinese curriculum standards. Provinces choose among these textbook versions the textbook that is associated with the biology exam that the province has chosen to use. The five versions are as follows:

Zhu, Z., & Zhao, Z. (2004). *Biology: Ordinary high school curriculum standard experiment textbook*. Beijing, China: People's Education Press.

Zhang, S. (2004). *Biology: Ordinary high school curriculum standard experiment textbook*. Beijing, China: Sinomapi Press.

Wang, Z. (2004). *Biology: Ordinary high school curriculum standard experiment textbook*. Nanjing, China: Jiangsu Education Press.

Liu, Z. (2004). *Biology: Ordinary high school curriculum standard experiment textbook*. Shijiazhuang, China: Hebei Children Press.

Liu, X., & Liu, E. (2004). *Biology: Ordinary high school curriculum standard experiment textbook*. Hangzhou, China: Zhejiang Science and Technology Press.

This study chose to use the Zhu & Zhao version given that this is the most widely used biology textbook version in China. Most provinces of China take the textbook as the appointed teaching material of the college entrance examination. Furthermore, Lu and Liu (2012) argue that the Zhu & Zhao version is the version most consistent with the Ordinary High School Biology Curriculum Standards. This textbook is actually composed of six smaller books (or sub-books) for each of the six content areas shown in Table 2. Specifically, this study focused on the three sub-books most closely related to the national examination. From each sub-book, a chapter similar in content to the AAAS standards (Table 2) was chosen:

Sub-book One (Zhu & Zhao, 2004a): Chapter four, Substances Input and Output of Cells.

Sub-book Two (Zhu & Zhao, 2004b): Chapter six, From the Cross Breeding to Genetic Engineering.

Sub-book Three (Zhu & Zhao, 2004c): Chapter three, The Hormonal Regulation of Plants.

Analytical Criterion

These chapters were evaluated using the AAAS textbook standards (1993), composed of seven categories: (a) providing a sense of purpose, (b) taking account of student ideas, (c) engaging students with relevant phenomena, (d) developing and using scientific ideas, (e) promoting students' thinking about phenomena, experiences, and knowledge, (f) assessing progress, (g) enhancing the science learning environment (AAAS, 1993). Each of the seven categories has a set of indicators. In this study, the three

sub-books were evaluated using the seven categories and their indicators.

Data Analysis

The research data were processed using SPSS 16.0 (Statistical Product and Service Solutions) statistical software. The data were interpreted considering frequency (f) and percentage (%). Correlations between the three biology compulsory modules and criteria were analyzed by Pearson Correlation Analyze.

RESULTS AND DISCUSSION

The data sources of this study were three biology compulsory modules of the ordinary high school biology textbook published by people's education press. Three chapters were analyzed based on the AAAS textbook standards. Each indicator of meeting the criteria was answered by "yes" or "no" and explained carefully. Analytical data extracted from the three sub-books are shown in Table 3.

Content Analysis

In this study, some indicators were met by three chapters (0=no problem). But some indicators were not met by one chapter (1=unique problem). Some indicators were not met by two chapters (2=less problems). Some indicators were not met by three chapters (3=common problems). The specific indicators are shown in Table 4. In this study, 21.6% of the indicators are common problems; 14.9% of the indicators are less problems; 21.6% of the indicators are unique problem; 41.9% of the indicators are no problem (see Table 4). The Zhu & Zhao version textbook meets most of the AAAS textbook standards. However, there are some problems within the three chapters. The specific problems are generalized below.

The weaknesses of the textbook. The Chinese ordinary high school biology textbook does not include a sufficient number and variety of phenomena relevant to the set of key ideas. Central concepts in the textbook are not covered in enough depth to give students a chance to truly understand them. Even though each chapter includes some experiment activities, students are given little guidance in interpreting the results in terms of the scientific concepts to be learned. Clear and specific objectives are necessary for science literacy (AAAS, 1993). However, chapter objectives of the textbook are not expressed in a way that is comprehensible to students. In some chapters, the stated purpose is presented in the form of a problem. The problem is not interesting to all students. Some students really like the problem and knows that the knowledge is important to the world, but most students must learn the knowledge just for taking exams, going

to universities, and preparing for their future work. The textbook really provides opportunities for students to think about and discuss some questions. However, usually only a small proportion of students discuss these questions in class, which is made up of forty to sixty people. The number of students in a class can potentially affect the students' learning in many different ways (Ehrenberg, Brewer, Gamoran, & Willms, 2001). "Large class size is a result of limited classroom space and the broad range of students' learning abilities intensified the struggle to reach each student" (Robertson & Jones, 2013, p. 1476). Therefore, it is a struggle for the textbook to provide suggestions to encourage each student to express, clarify, justify, and represent ideas.

Furthermore, the significant deficiency of the textbook is that it does not provide specific suggestions for teachers about how to interpret student responses, modify activities for students with special needs, and provide explicit feedback to students. New and

inexperienced teachers rely almost entirely on textbooks for teaching (Tyson, 1997). Çobanoğlu et al. (2009) point out, "Those textbook-oriented teachers are very dependent on the content of the textbooks; that they do not focus on topics like Science-Technology-Society, personal needs and career sensitivity and that they do not spend time on any of these topics" (p. 2505). Teachers are the ultimate deciders of what is taught. "No one would be surprised by the statement that students are more likely to learn the content that they are taught" (Porter, 2002, p. 3). Teacher feedback has a great influence on students' achievements (Hattie, 1993). However, the textbook has no texts that directly provide students with feedback. There are no sufficiently detailed answers to questions in the student book for teachers to understand and interpret various student responses. It is difficult for teachers to check students' learning progress in class. Although the textbook consistently carries out the expected performance and the performance is step by step, it

Table 3. Analytical data extracted from three sub-books

Category	The number of indicators	Sub-book One (Chapter 4)		Sub-book Two (Chapter 6)		Sub-book Three (Chapter 3)	
		Yes	No	Yes	No	Yes	No
a	13	10	3	5	8	9	4
b	15	10	5	10	5	12	3
c	5	4	1	2	3	2	3
d	13	9	4	8	5	8	5
e	11	7	4	6	5	7	4
f	7	6	1	5	2	4	3
g	10	4	6	3	7	5	5

Table 4. Distribution of the indicators within three sub-books

Category	Specific Indicators	f	%
0	1.1.5, 1.1.6, 1.2.1, 1.2.5, 2.1.1, 2.1.2, 2.1.5, 2.2.2, 2.3.1, 2.3.3, 2.4.1, 2.4.2, 3.2.2, 4.1.1, 4.2.1, 4.2.3, 4.3.1, 4.4.2, 4.4.3, 5.1.1, 5.1.5, 5.2.1, 5.2.2, 5.2.3, 5.3.2, 6.1.1, 6.2.1, 6.2.2, 7.1.3, 7.2.2, 7.3.1	31	41.9
1	1.1.1, 1.1.2, 1.2.4, 1.3.1, 1.3.2, 2.1.3, 2.1.4, 2.3.4, 3.1.1, 3.2.1, 4.1.2, 4.2.2, 4.3.2, 5.3.1, 6.1.2, 6.3.1	16	21.6
2	1.2.2, 1.2.3, 2.2.1, 2.3.2, 3.1.2, 4.3.3, 6.3.2, 6.3.3, 7.1.1, 7.3.3, 7.3.5	11	14.9
3	1.1.3, 1.1.4, 2.3.5, 2.4.3, 3.2.3, 4.3.4, 4.4.1, 4.4.4, 5.1.2, 5.1.3, 5.1.4, 5.3.3, 7.1.2, 7.2.1, 7.3.2, 7.3.4	16	21.6

Note: 0=no problem; 1=unique problem; 2=less problems; 3=common problems.

Table 5. Correlations between the chapter ratings and the AAAS textbook standards

	The AAAS textbook standards	Sub-book One (Chapter 4)	Sub-book Two (Chapter 6)	Sub-book Three (Chapter 3)
The AAAS textbook standards	1			
Sub-book One (Chapter 4)	.853*	1		
Sub-book Two (Chapter 6)	.811*	.820*	1	
Sub-book Three (Chapter 3)	.968**	.901**	.867*	1

Note: *p < .05, **p < .01.

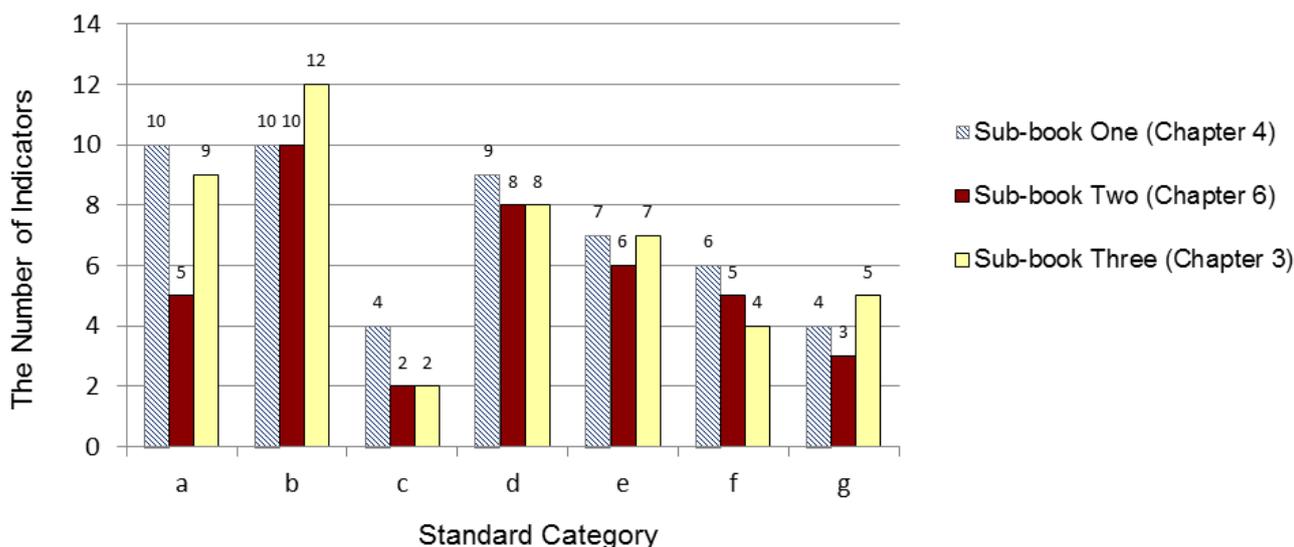


Figure 1. Results of meeting the AAAS textbook standards

does not provide running commentaries that point to particular aspects of the demonstration and criteria for judging the quality of a performance. The teaching material associates with the final objective of the national university entrance exam. It is impossible for the textbook to avoid dogmatism. If educators think about these problems, the quality of the typical Chinese high school biology textbook will be improved.

The strengths of the textbook. The strengths of the Chinese ordinary high school biology textbook are obvious. Representation of the textbook is accurate and concise. Many pictures and diagrams are embedded in the text. Students can easily understand some experimental phenomena. There is no language or stereotypes that might be offensive to a particular group. Most lessons of the textbook are consistent with the stated purpose and those that are not explicitly labeled as digressions. These lessons meet the objectives of the chapter. There is a brief summary part at the end of each chapter. The lessons and discussions are wrapped up in this part. Students are able to learn the main knowledge points and master the objectives very well. Every chapter prompts teachers to convey the purpose of the activity to students. For example, teachers are encouraged to introduce a series of experiments to students in order to demonstrate the discovery process of auxin on page 47 of biology compulsory three (Zhu & Zhao, 2004). Biology teachers are required to have a solid grounding in the content they teach and an understanding of how diverse students can be helped to learn (AAAS, 1993). The textbook not only engages students in thinking about what they have learned and what they need to learn next at the beginning of each chapter, but also alerts teachers to specific prerequisite ideas rather than stating

prerequisite topics or terms. Each chapter of the textbook specifies the prerequisite knowledge and skills that are necessary to learn the following key ideas. The textbook provides instructional support for connections between ideas treated in a particular unit and their prerequisites even if the prerequisites are addressed elsewhere.

In addition, the textbook explicitly addresses commonly held ideas and clarifies these commonly held ideas in detail, rather than just listing them. For instance, chapter six of biology compulsory two illustrates the safety of genetically modified organisms and foods very clearly on page 105 (Zhu & Zhao, 2004). The textbook provides students with vivid first-hand experiences. Every chapter of the textbook provides a sequence of questions, activities, or novel tasks in which the complexity is progressively increased. These questions, activities, or tasks have helpful characteristics. They can be used to help teachers to identify students' ideas and prompt students to contrast commonly initial ideas with the scientifically correct ideas. Brandwein (1981) indicated that scientific terms in textbooks play an important role in the subject teaching. The technical terms of this textbook are accurately represented and explicitly linked to relevant experiences. Most students are able to understand the relationship between scientific ideas and the phenomena that they can explain. For example, apical dominance of plants is linked to the physiological functions of auxin in chapter three of biology compulsory three (Zhu & Zhao, 2004). In the text, picture and its accompanying interpretation are both excellent. Students can understand scientific ideas very well.

What's more, the textbook provides examples of classroom interactions (e.g., dialogue boxes, vignettes,

or video clips) that illustrate appropriate ways to respond to students' questions or ideas. These examples are good to classroom instruction. Research has reported that 90% of all science teachers use textbooks for classroom instruction (Weiss, Nelson, Boyd, & Hudson, 1989). There is a self-test part at the end of each chapter. These assessment items include both familiar and novel tasks and focus on understanding of key ideas. Students' errors can be diagnosed through these assessment items. Their ideas can be further developed under the guidance of teachers.

In view of the above analysis, we derive the fact that the textbook is satisfactory. Figure 1 shows how well the three sub-books meet the AAAS textbook standards. It reveals that sub-book one and three meet the AAAS textbook standards very well. The three sub-books meet the second category standard best, but meet the third category standard worst (see Figure 1).

Correlation Analysis

Correlations between the chapter ratings and the AAAS textbook standards were analyzed based on the results of meeting the criteria. The data were analyzed by SPSS16.0 program. Pearson correlation coefficient is used to determine close degree of their relations. The values of correlation coefficient are reported in Table 5. The three chapters and the AAAS textbook standards have significant correlations ($n=7$, $p < .05$). There is a highly significant correlation between sub-book one and sub-book three ($n=7$, $p < .01$, $r = .901$). There is a highly significant correlation between sub-book three and the criteria ($n=7$, $p < .01$, $r = .968$) (see Table 5). The results show that the Zhu & Zhao version textbook meets the AAAS textbook standards. Sub-book three aligns with the AAAS textbook standards very well.

CONCLUSIONS

This study revealed that the Zhu & Zhao version textbook meets most of the AAAS textbook standards. The typical Chinese high school biology textbook is satisfactory. The Chinese biology textbook is characterized by well-selected material and accurate representation. However, the significant deficiency of the textbook is that it does not provide specific suggestions for teachers about how to interpret student responses, modify activities for students with special needs, and provide explicit feedback to students. Correlation analysis showed that the three chapters and AAAS textbook standards have significant correlations. Sub-book three aligns with the AAAS textbook standards very well. The study helps education researchers to carry out the quality-oriented education. It can not only promote the cultural communication between different countries, but also encourage domestic and abroad scholars' academic exchanges. In a

sense, this paper will improve the Chinese high school biology education system and put forward constructive suggestions for the implementation of the high school curriculum standards. Knowing the alignment between the typical Chinese biology textbook and the AAAS textbook standards can be beneficial to the improvement of Chinese high school biology textbooks.

Recommendations

Chinese high school biology textbooks are major curricular resources that provide the subject matter content for what is taught in biology classrooms and how the content is taught. They embody the learning content and requirements of the Chinese curriculum standards. To make good use of the Chinese high school biology textbook, educators should take into account the problems existing in the textbook. A good curriculum material can be a powerful driving force for improving teaching and learning (Ball & Cohen, 1996). "Today, textbooks are no longer single entities available to teachers" (Chiappetta & Fillman, 2007, p. 1864). There is no doubt that good texts of a textbook can provide students with a framework for developing an understanding of the nature of science theory. Therefore, it is necessary for the Chinese high school biology textbook to provide the right content and instructional support. In the education process, the central role of the Chinese biology textbook should prevent the effective science education from reaching to the target demanded level. Of course, it will be beneficial to the textbook that the texts of the textbook cover the key ideas that students need for literacy in the biological field and provide research-based instructional strategies that teachers can use to help students learn those ideas.

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