

A Comparative Study of High School Mathematics Curriculum Standards in China and the United States

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Abstract. This study examines the high school mathematics curriculum standards of China and the United States, focusing on China’s General High School Mathematics Curriculum Standards (2017 Edition, Revised in 2020) (hereinafter referred to as the “China Standards”) and the high school section of the U.S. Common Core State Standards for Mathematics (CCSSM) (hereinafter referred to as the “U.S. Standards”). Through a detailed comparative analysis of the historical background, framework, curricular philosophy and characteristics, competencies and objectives, as well as content and level requirements of these standards, this study aims to provide insights and references for the further revision and reform of China’s mathematics curriculum standards. The findings hold both representative and universal significance.

Keywords: mathematics curriculum standards, high school, China-U.S. comparison

1. Comparison of the Backgrounds of the China-U.S. Standards

1.1. The U.S. Common Core State Standards for Mathematics

The introduction of the Common Core State Standards for Mathematics (CCSSM) was both an inevitable outcome of educational reform and a necessary response to contemporary trends. As a decentralized country, the United States has traditionally lacked a uniform national curriculum standard. The emergence of a unified standard must be understood through the lens of historical developments and educational reforms.

Table 1. Evolution of the Historical Background of the U.S. Common Core State Standards for Mathematics

Time Period	Educational Reform	Impact
1950s	New Math Movement	Mathematics gradually became more unified, standardized, structured, and abstract. Emphasis on modern mathematical content. Neglected principles of cognitive learning. Weak alignment between curriculum design and student learning needs.
1970s	Back to Basics Movement	Focus on fundamental knowledge and basic skills. Prioritized rote learning over understanding and application. Overlooked students with higher mathematical proficiency. Reemphasized real-world applications.
1980s	Problem-Solving Approach	Shifted towards a student-centered learning model. Introduced the concept of “mathematics for all.” However, there was disorder among states, with significant disparities in resource allocation.
1990s	Standards Movement	Published a series of standard-setting documents. Marked a shift towards standardized mathematics education.

A review of the reforms in U.S. mathematics curriculum standards since the 1950s reveals a progressive trend toward greater standardization and regulation. The adjustments have evolved from broadening mathematical content, to reinforcing foundational knowledge, to emphasizing real-world applications, and ultimately to implementing standardized guidelines. The United States has consistently strived to improve K-12 mathematics education nationwide. Following the emergence of curriculum standardization reforms in the late 20th century, concerns arose regarding the poor performance of American students in international assessments such as TIMSS and PISA. The root cause was the inconsistency in curriculum standards across states, which varied significantly in quality [3]. Consequently, the U.S. sought to enhance educational quality through the adoption of rigorous, coherent, and well-defined national curriculum standards. To this end, several significant standards were introduced. The Professional Standards for Teaching Mathematics (NCTM, 1991) and the Assessment Standards for School Mathematics (NCTM, 1995) were the first to establish teaching and assessment criteria for grades K-12. These were later refined into the Principles and Standards for School Mathematics, which revised the emphasis on problem-solving and highlighted the importance of logical reasoning and argumentation, though the standards remained somewhat broad. Subsequent publications, such as *Adding It Up: Helping Children Learn Mathematics* (2000) and *Curriculum Focal Points* (2006), built upon the Standards 2000, adding specificity and guidance at each grade level. These documents emphasized fundamental knowledge and skills as core components, ensuring a focused and consistent curriculum [4]. Against this backdrop, in June 2010, the National Governors Association (NGA) and the Council of Chief State School Officers (CCSSO) conducted international curriculum comparisons, assessed the realities of the U.S. education system, and gathered expert opinions. This culminated in the release of the Common Core State Standards for Mathematics (CCSSM). To date, 45 states and the District of Columbia have adopted these standards, triggering a new wave of nationwide educational reform based on a unified curriculum framework [5].

1.2. China's Mathematics Curriculum Standards for General Senior Secondary Schools (2017 Edition, 2020 Revision)

In contrast to the decentralized political system of the United States, China is a socialist country that has consistently adhered to the revision, improvement, and implementation of a unified curriculum standard as part of its path toward becoming an educational powerhouse. Since the founding of the People's Republic of China, twelve teaching syllabi, three curriculum standards, and one simplified outline have been issued specifically for high school mathematics[6]. The major historical developments are outlined in the table below (not all documents are included, only selected ones). Against this backdrop, the Mathematics Curriculum Standards for General Senior Secondary Schools (2017 Edition, 2020 Revision) was officially issued as the latest version of the high school mathematics curriculum standard.

Table 2. Evolution of the Historical Background of China's Mathematics Curriculum Standards for General Senior Secondary Schools (2017 Edition, 2020 Revision)

Time Period	Stage	Issued Document	Impact
1949-1957	Transformation of the Old Education System with Reference to Soviet Experience	Draft of the Simplified Outline for General Secondary School Mathematics Teaching (1950), Draft of the Mathematics Curriculum Standards for Secondary Schools (1951), Draft of the Secondary School Mathematics Teaching Syllabus (1952), Revised Draft of the Secondary School Mathematics Teaching Syllabus (1957)	Set the 6-3-3 schooling system Divided high school mathematics into algebra, geometry, and trigonometry, excluding analytic geometry Adopted a linear, progressive curriculum structure Introduced the concept of "Double Basic" Advocated for the scientific value of mathematics Narrow scope, shallow content, and dogmatism
1958-1965	Comprehensive Exploration of Chinese Socialist Education	Draft of the Full-time Secondary School Mathematics Teaching Syllabus (1961)	Added analytic geometry in high school and included approximate calculations, variable methods, and derivatives in algebra. Clarified the concepts of "basic knowledge," "basic skills," and "three abilities" (computational ability, logical reasoning ability, spatial imagination ability).
1966-1976	Severe Disruption of Educational Development	No unified national mathematics syllabus or textbooks	Self-published textbooks with strong utilitarian focus. Chaotic mathematics education order.

Table 2. (continued).

1977-1986	Restoration of Normal Educational Order and Preliminary Exploration of Socialist Education with Chinese Characteristics	Trial Draft of the Full-time Ten-Year School Secondary Mathematics Teaching Syllabus (1978), Consultation Draft of the Full-time Six-Year Key Secondary School Mathematics Teaching Syllabus (1981), Full-time Secondary School Mathematics Teaching Syllabus (1986)	Basic knowledge and skills essential for participation in industrial and agricultural production and for learning modern science and technology. Added introductory knowledge of calculus, probability, and modern mathematical concepts such as sets and mappings. Learning requirements became more specific.
	Implementation of Compulsory Education and Comprehensive Construction of Socialist Education with Chinese Characteristics	Trial Revised Version of the Full-time General Senior Secondary School Mathematics Teaching Syllabus (2000), Mathematics Curriculum Standards for General Senior Secondary Schools (Experimental) (2003), Mathematics Curriculum Standards for General Senior Secondary Schools (2017 Edition, 2020 Revision)	Introduced compulsory and elective courses. Added research topics as required electives. The term “syllabus” was renamed “curriculum standards.” A more comprehensive understanding of the functions of mathematics education. Focus on the holistic nature of knowledge. Shift from a three-dimensional goal to a competency-oriented approach.
1978-Present			

By comparing the historical backgrounds of the U.S. and Chinese Standards, it becomes evident that since the late 1980s, both countries have increasingly emphasized curriculum or educational standards in their basic education reforms. The term “standard” has become a key term in basic education reform, especially in curriculum reform [7]. Based on this, both the U.S. and China have, from an international perspective, explored more appropriate mathematics curriculum standards for their respective national contexts through repeated practice to advance the development of national mathematics education. The U.S. standards were shaped around two core issues: “fundamentals” and “applications,” under the context of the “standards movement,” and became a unified core standard among states. China, on the other hand, has undergone more revisions of its standards, evolving from syllabi to curriculum standards, with a more integrated approach to knowledge and a shift towards a core competency-oriented framework, adapting to the development of the times and China’s national conditions, while gradually emphasizing the educational value of mathematics.

2. Comparison of the Frameworks of the Chinese and U.S. Standards

2.1. General Framework

Both the Chinese and U.S. mathematics curriculum standards possess universality and a rigorous logical structure, offering strong guidance for mathematics education in both countries and high theoretical value for bridging teaching and learning. The general framework of the U.S. State Core Mathematics Curriculum Standards is divided into three main parts: “Introduction,” “Mathematical Practice Standards,” and “Mathematical Content Standards.” The introduction primarily covers the characteristics, focus areas, overall overview, and how to read and use the U.S. standards. The specific entries in the mathematical practice standards address mathematical literacy and the overall goal levels of student practice in learning mathematics. The mathematical content standards further break down the specific mathematics learning fields and the required levels of achievement for K-12 grades. The general framework of China’s General High School Mathematics Curriculum Standards (2017 Edition, 2020 Revision) is divided into six main parts: “Curriculum Nature and Basic Concepts,” “Core Literacy and Curriculum Objectives,” “Curriculum Structure,” “Curriculum Content,” “Academic Quality,” and “Implementation Suggestions.”

Table 3. Correspondence Between the Overall Frameworks of China and the U.S.

Chinese Standards		U.S. Standards	
Preface	Guiding Ideology and Basic Principles of Revision Main Revisions and Changes	First Chapter Introduction	1. Emphasizing key points and coherence;

Table 3. (continued).

Chapter 1: Curriculum Nature and Basic Concepts	Curriculum Nature Basic Concepts		2. Mathematical understanding 3. Reading guide
Chapter 2: Core Literacy and Curriculum Objectives	Core Literacy Curriculum Objectives	Chapter 2: Mathematical Practice Standards	8 Mathematical Practice Standards
Chapter 3: Curriculum Structure	Basis of Design Structure Credits and Course Selection	/	
Chapter 4: Curriculum Content	Required Courses Selective Required Courses Elective Courses Connotation of Academic Quality	Chapter 4: Mathematical Content Standards	K-12
Chapter 5: Academic Quality	Academic Quality Level Relationship Between Academic Quality Level and Examination Evaluation Teaching and Assessment Recommendations	/	
Chapter 6: Implementation Suggestions	Suggestions for Academic Level Examinations and Gaokao Proposition Suggestions for Textbook Development Recommendations for Local and School Implementation of Curriculum Standards		
Appendices	Appendix 1: Core Competencies Level Division Appendix 2: Teaching and Evaluation Cases	Chapter 4: Glossary Chapter 5: Consultation Samples	Terminology Definitions and Examples Existing Verifiable Literature

From the table above, it can be observed that while both the Chinese and U.S. standards outline the requirements for learning content, China organizes it based on the curriculum nature (such as required or elective courses), whereas the U.S. organizes it by grade level or conceptual categories. Compared to the U.S. standards, the general framework of the Chinese standards is more comprehensive and detailed. For example, in the “Curriculum Structure” section, the design basis, selection of required courses, and credits and curriculum selection are clearly outlined. In addition, the “Academic Quality” and “Implementation Suggestions” sections provide layered divisions of academic quality and give suggestions on teaching evaluation, textbook writing, and exam evaluation. These aspects are not explicitly stated in the U.S. standards. This reflects the flexible and free attitude of the U.S. standards, which do not mandate specific curriculum implementation or teaching methods for each state and locality; instead, they allow for adjustments based on actual circumstances. Furthermore, a comparison of the “Appendix” sections reveals that China focuses on literacy level divisions and practical case studies, while the U.S. enhances the rigor of its standards by defining terms and citing relevant literature.

A deeper comparison reveals further differences in how the two standards approach curriculum content. While the overall framework shows some structural differences, they share commonalities as well. Both cover curriculum concepts, objectives, and content requirements, with a similar overall arrangement. The “Introduction” in the U.S. standards encompasses the curriculum nature and concepts found in the preface and first chapter of the Chinese standards. China treats these topics separately, giving them individual sections, emphasizing their importance. Both standards also contain “Curriculum Objectives” and “Content Requirements,” with these key sections clearly presented in separate chapters. An in-depth analysis shows that both the Chinese and U.S. standards emphasize the development of abilities and literacy. In China’s standards, this is expressed as “core literacy,” while in the U.S. standards, it is articulated as “mathematical practice standards,” but both point toward specific capabilities and goals.

2.2. Content Framework

From a micro perspective, slight differences in the content framework become apparent. Taking the U.S. high school section as an example, it is organized logically according to “category—field—standard—group,” with a clear structure. The U.S. high school section includes six major categories: “Numbers and Quantities, Algebra, Functions, Modeling, Geometry, Statistics and Probability,” each subdivided into specific fields, standards, and groups, and each category includes an overview and general

discussions. This makes the progression of content requirements clear to the reader. The Chinese high school section includes four main lines: “Functions, Geometry and Algebra, Statistics and Probability, Mathematical Modeling and Mathematical Inquiry Activities.” These main lines are further divided into required, selectively required, and elective courses. The required and selectively required courses are organized according to the “field—content requirements—teaching suggestions—academic requirements” logic. Compared to the U.S. standards, China’s standards add “teaching suggestions” and “academic requirements,” reflecting a more comprehensive and detailed approach in the design of the Chinese curriculum standards. While the categories and fields in the U.S. standards are more numerous, they align with China’s structure, demonstrating a consistent conceptual framework between the two standards.

3. Comparison of the Curriculum Concepts in the Chinese and U.S. “Standards”

Curriculum concepts reflect the basic understanding, ideas, and attitudes toward the mathematics curriculum, its content, teaching, and evaluation. They serve as guiding principles for formulating and implementing mathematics curricula [8]. As the core guiding principle of the mathematics curriculum, the curriculum concept plays an important role in providing clear teaching direction, promoting teaching reform, improving teaching quality, and perfecting the mathematics education system. While the curriculum concepts in the Chinese and U.S. “Standards” may appear to differ significantly due to differing national contexts, a deeper analysis reveals their inherent unity.

In the U.S. “Standards,” the curriculum concept is not presented as a separate section but is included in the introduction, which consists of three parts. In the first two parts, the curriculum concepts are presented as titles: “Emphasizing Focus and Coherence” and “Mathematical Understanding.” In the “Emphasizing Focus and Coherence” section, “focus” refers to the core ideas, concepts, and principles of mathematics, while “coherence” emphasizes the internal connections of knowledge, meaning that the learning of mathematical knowledge should follow a logical progression from basic to more advanced concepts. In the “Mathematical Understanding” section, the focus is on the ability to explain mathematical principles, rules, and patterns, highlighting the need for learners to provide reasonable explanations and understand the essence of mathematics. The third section, “Reading Guide,” offers specific guidance on how to read the standards for each grade level, incorporating the key ideas of “flexibility, coherence, and development” in the final three paragraphs. “Coherence” and “flexibility” focus on the relationship between new knowledge and prior learning, suggesting that teachers can explore connections within the standards. “Development” emphasizes the importance of learning from past experiences and continually improving and refining the curriculum.

In the Chinese “Standards,” the curriculum concept is presented in Chapter 1 and is elaborated from four major aspects. The logic of these elaborations is very rigorous. First, the educational value of the mathematics curriculum is outlined, emphasizing the importance and role of core competencies. Next, the specific curriculum concepts based on fostering competencies are explained. The first concept, “Student Development-Centered, Virtue Cultivation, Enhancing Competencies,” reflects the universal nature of mathematics learning, the individual development of students, and the fundamental goal of virtue cultivation. The second concept, “Optimizing Curriculum Structure, Highlighting the Main Theme, Selecting Content,” focuses on structuring and integrating content, emphasizing the internal logic and systematic nature of knowledge, and highlighting key learning areas and practical applications to help develop students’ core competencies. The third concept, “Grasping the Essence of Mathematics, Inspiring Thought, Improving Teaching,” encourages the development of students’ deeper understanding of mathematics in real-world contexts, adapting to the trends of the times. The fourth concept, “Emphasizing Process Evaluation, Focusing on Competencies, Improving Quality,” stresses the importance of multiple forms of evaluation and the continuous improvement of teaching and learning to enhance knowledge, skills, and core competencies.

Through comparison, it becomes clear that there are some differences between the Chinese and U.S. “Standards.” China’s curriculum concept places greater emphasis on diverse learning evaluation methods based on fostering competencies, aiming for learners to develop attitudes, emotions, and mathematical beliefs to deepen their understanding of the diverse values of mathematics. Chinese curriculum concepts also emphasize the integration of moral education into subject learning. In contrast, the U.S. curriculum concept focuses more on the internal systematization and depth of knowledge at each grade level, addressing the issue of “one mile wide, one inch deep.” However, there are also similarities between the two curriculum concepts, as both highlight the student-centered core concept in the selection, organization, and presentation of curriculum content, aiming to enhance students’ understanding of fundamental mathematical concepts and principles, their practical insights into mathematics, and the appropriateness of mathematical knowledge for students’ cognitive development. Additionally, both the Chinese and U.S. standards share core concepts such as “universal participation, individual development, internal logic of knowledge, systematization and coherence, real-world application, and the auxiliary role of information technology.”

4. Comparison of the Curriculum Objectives in the Chinese and U.S. “Standards”

The “Mathematical Practice Standards” chapter in the U.S. “Standards” reflects the goals of mathematical learning. It emphasizes process-oriented standards such as problem-solving, reasoning and proof, mathematical communication, mathematical representation, and mathematical connections. It also highlights core practical abilities such as mathematical understanding and mathematical modeling, aiming to cultivate students’ mathematical literacy and practical application skills. The U.S. “Standards” propose 8 mathematical practice standards. The Chinese “Standards” not only emphasize six core competencies but also focus on

the cultivation pathways for these competencies, realized through the “Four Basics” and “Four Abilities.” Therefore, it can be observed that the 8 practice standards in the U.S. “Standards” cover the requirements for the “Four Basics,” “Four Abilities,” and core competencies in the Chinese “Standards.” The inclusion relationships are shown in Table 4.

Table 4. Comparison of Curriculum Objectives in the Chinese and U.S. “Standards”

U.S. “Standards” Practice Requirements		Chinese “Standards” Four Basics, Four Abilities, and Core Competencies
Overall Statement	Specific Description	
1. Understand the problem and persist in solving it	From conjecture to verification	Logical reasoning
	Self-monitoring and evaluation	Basic activity experience
	Analogous comparison with other problems	Analogical thinking
	Digging out connections and regularities	Logical reasoning
	Considering essential consistency and correlation	Analogical thinking
2. Abstraction and quantification reasoning	De-contextualization ability	Mathematical abstraction, logical reasoning
	Contextualization ability	Discovering problems, posing questions, data analysis, mathematical modeling
3. Constructing feasible arguments, evaluating others’ reasoning	Inductive reasoning, constructing arguments, rigorous proofs	Logical reasoning
	Communication and evaluation, drawing conclusions, reflecting on reality	Basic activity experience
4. Mathematical modeling	Constructing models, solving problems	Solving problems, mathematical modeling
5. Reasonably using appropriate tools	Using tools to solve problems	Analyzing problems, solving problems, intuitive imagination
6. Focusing on accuracy	Calculation accuracy	Mathematical operations
7. Seeking and using structure	Recognizing patterns and structures	Basic knowledge, mathematical abstraction
8. Seeking regularity in ongoing reasoning	Applying regularities for simplification	Basic skills, simplification thinking, logical reasoning

The “Mathematical Practice Standards” and “Mathematical Core Competencies and Curriculum Objectives” differ in their focus and presentation style. The U.S. “Standards” emphasize specific mathematical practice skills that students should master. They focus on operational guidance and repeatedly mention “mathematical connections,” stressing the need to solve the problem of “one mile wide, one inch deep,” with a focus on interdisciplinary applications and a deep understanding of mathematical concepts. In contrast, the Chinese “Standards” focus on the “Four Basics” and “Four Abilities,” promoting the development of core competencies in a comprehensive and multi-level manner, aiming to achieve a holistic enhancement of students’ competencies.

5. Comparison of the Curriculum Content in the Chinese and U.S. “Standards”

5.1. Comparison of Knowledge Domain Divisions

Mathematical content is a key component in the mathematics curriculum standards, and it imposes specific requirements on textbook development and the learning of content. Therefore, it is necessary to compare the “Mathematical Content Standards” and “Curriculum Content” in the Chinese and U.S. “Standards.” As shown in Table 5.

Table 5. Comparison of Key Concepts and Knowledge Domains in the Chinese and U.S. “Standards”

Chinese Content Modules	U.S. Content Modules	Chinese “Standards” Key Concepts	U.S. “Standards” Key Concepts	Chinese “Standards” Knowledge Areas	U.S. “Standards” Knowledge Areas
Geometry and Algebra	Functions	1. Basic elementary functions; 2. The relationship between functions and equations; 3. The application of functions.	1. Functions; 2. The relationship between functions and expressions, equations, models, coordinates.	1. The concept and properties of functions; 2. Power functions, exponential functions, logarithmic functions; 3. Trigonometric functions; 4. Applications of functions; 5. The connection between functions and equations and inequalities; 6. Sequences; 7. Inverse derivative of single-variable functions and its applications.	1. Understanding functions; 2. Creating functions; 3. Linear functions, quadratic functions, and exponential function models; 4. Trigonometric functions.
	Numbers and Quantities		1. Numbers and number systems; 2. Quantities.		1. Real number system; 2. Quantities; 3. Complex number system; 4. Vectors and matrices.
	Algebra	1. Quantities and relationships; 2. Expansion of number systems; 3. The relationship between geometric figures (plane, solid) and quantities and equations.	1. Expressions; 2. Equations and inequalities.	1. Equalities and inequalities; 2. Plane vectors and their applications; 3. Complex numbers; 4. Introduction to solid geometry; 5. Spatial vectors and solid geometry; 6. Plane analytic geometry (equations of lines and circles, equations of conic sections).	1. Understanding the structure of expressions; 2. Operations with polynomials and rational expressions; 3. Constructing equations; 4. Reasoning with equations and inequalities.
	Geometry		1. Understanding congruence, similarity, and symmetry from a geometric transformation perspective; 2. Analytical geometry, relating algebra to geometry; 3. Connections with equations.		1. Congruence; 2. Similarity, right triangles, and trigonometric functions; 3. Circles; 4. Shapes and equations; 5. Geometric measurement and dimensions; 6. Geometric modeling.

Table 5. (continued).

Probability and Statistics		1. Statistics and its applications; 2. Probability, probability distributions, and their applications.	1. Statistics and decision-making; 2. Statistics and the relationship with functions and modeling.	1. Statistics (data analysis); 2. Probability (random variables and distributions); 3. Counting principles.	1. Interpreting categorical and quantitative data; 2. Making decisions based on statistics and justifying them; 3. Conditional probability and probability rules; 4. Using probability to make decisions.
				Mathematical modeling is the process of abstracting real-world problems, expressing them in mathematical language, building models using mathematical methods, and solving problems.	Mathematical models connect the mathematical knowledge learned in class with real-life situations, appropriately applying relevant knowledge to analyze and solve problems.
Mathematical Modeling and Mathematical Inquiry Activities	Modeling	Modeling and its basic process.	Modeling and its standards		

5.2. Comparison of Content Requirements Levels

5.2.1. Cognitive Level Division

By organizing the content of the Chinese and U.S. “Standards,” cognitive levels and their expressions are divided into four main levels: “Understand, Comprehend, Master, and Apply.” The specific expressions in the standards are further refined into specific action verbs.

Table 6. Reference Table for Cognitive Level Coding in the Standards

Cognitive Level	Specific Action Verbs
Understand	Understand, experience, know, identify, perceive, recognize, imitate, seek, calculate, obtain, measure, classify/order, preliminarily understand, preliminarily experience, preliminarily learn, preliminarily comprehend
Comprehend	Describe, explain, express, articulate, represent, depict, interpret, hypothesize, imagine, implement, understand, generalize, summarize, synthesize, abstract, extract, compare, transform, contrast, determine, judge, seek, be able to, apply, model, solve simple problems, investigate, preliminarily apply, preliminarily discuss
Master	Master, derive, analyze, deduce, prove, study, discuss, select, use, deeply understand
Apply	Solve problems (comprehensive problems with mathematical and real-world contexts)

5.2.2. Comparison of Content Requirements in Different Fields of the Standards

By comparing the required mastery levels for students across different fields in the Chinese and U.S. “Standards,” and integrating the logic of standard organization and content classification, the comparison is divided into three main parts: Functions and Equations, Geometry and Algebra, and Statistics and Probability. The study primarily follows the classification method in the Chinese “Standards,” referencing the corresponding content in the U.S. “Standards,” and reclassifying the inconsistent parts through selection and integration.

5.2.2.1. General Analysis

As shown in Figure 1, in the field of Functions and Equations, China's requirements show a decreasing trend from "Understand," "Comprehend," and "Master," to "Flexible Application," indicating that the mastery of functions and equations in China primarily stays at the "Understand, experience, know, calculate" levels. In contrast, the U.S. "Standards" have the highest proportion at the "Comprehend" level, accounting for more than fifty percent, reflecting a difference in the focus of textbook content between the two countries in the field of functions and equations. Meanwhile, for the level of "Flexible Application," both standards are below 7%, showing a weaker emphasis on the application of functions.

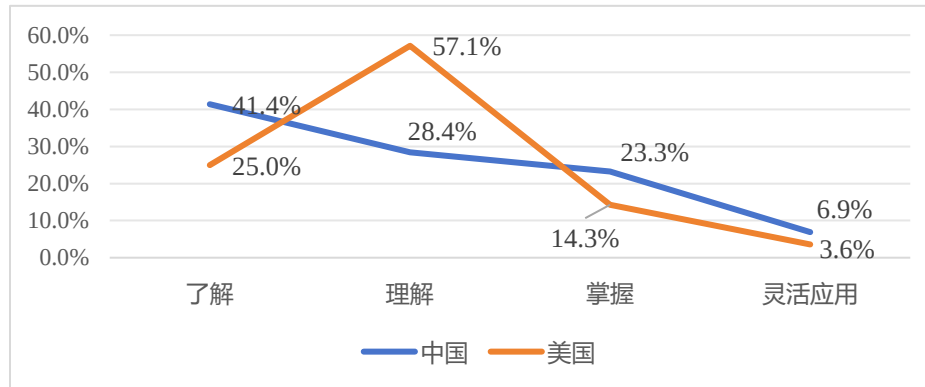


Figure 1. Line Chart Comparing Content Requirements in the Field of Functions and Equations in the U.S. and Chinese Standards

Note: The blue color in the figure represents China, and the orange color represents the United States. The horizontal axis, from left to right, represents "Understand," "Comprehend," "Master," and "Flexible Application."

In the field of Geometry and Algebra, both the U.S. and Chinese "Standards" show consistent requirements across the four aspects of content. The line chart illustrates that both countries emphasize the "Comprehend" level in this area, with the requirements for "Understand" and "Master" being almost identical, reflecting a consistency between the two countries in this field, as shown in Figure 2.

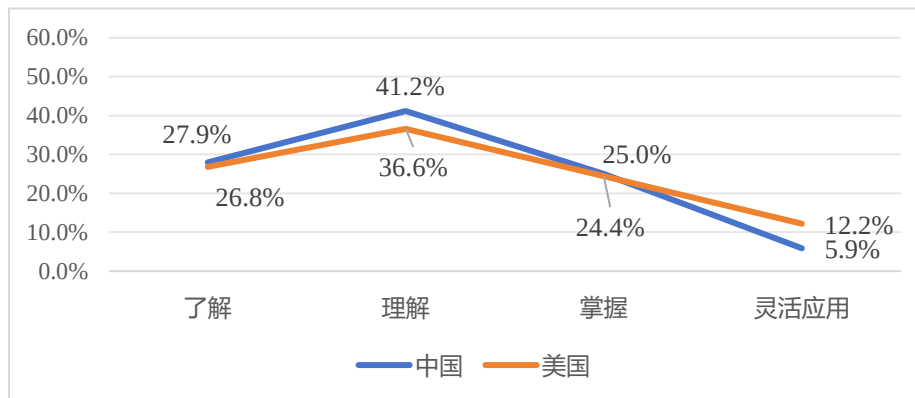


Figure 2. Line Chart Comparing Content Requirements in the Field of Geometry and Algebra in the U.S. and Chinese Standards

Note: The blue color in the figure represents China, and the orange color represents the United States. The horizontal axis, from left to right, represents "Understand," "Comprehend," "Master," and "Flexible Application."

In the field of Statistics and Probability, the U.S. "Standards" show the highest value at the "Comprehend" level, reaching 56.3%, focusing on requirements such as "describe, represent, explain, understand, judge," etc. In contrast, the Chinese "Standards" exhibit smaller fluctuations across all levels, but the emphasis on "Flexible Application" stands out, reflecting a better focus on understanding the probability of random events in real-world contexts and going through the process of data statistics, as shown in Figure 3.

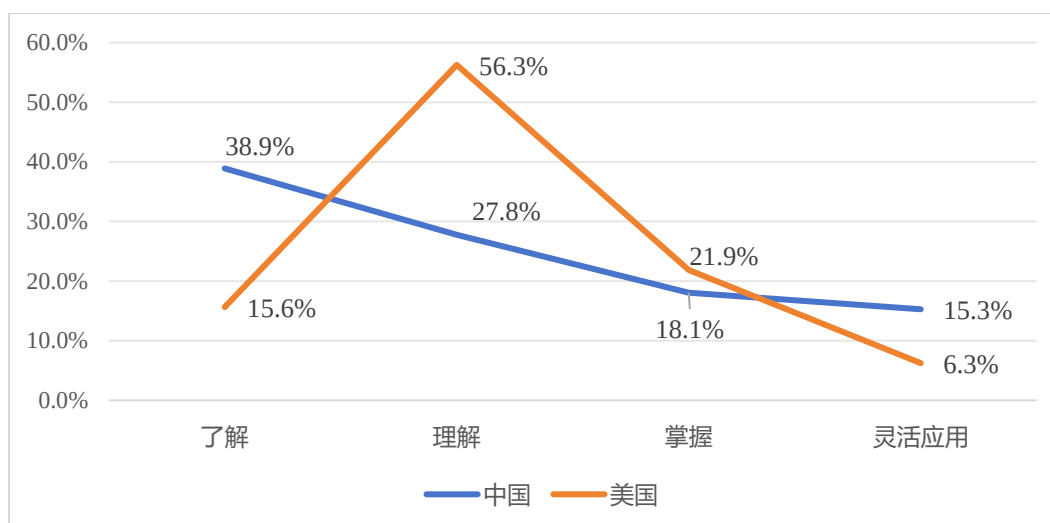


Figure 3. Line Chart Comparing Content Requirements in the Field of Statistics and Probability in the U.S. and Chinese Standards

Note: The blue color in the figure represents China, and the orange color represents the United States. The horizontal axis, from left to right, represents “Understand,” “Comprehend,” “Master,” and “Flexible Application.”

A comprehensive comparison of the content requirements in the U.S. and Chinese “Standards” reveals that both countries are generally equal in their emphasis on mastery and flexible application. However, there are differences at the “Understand” and “Comprehend” levels. As shown in the line chart, significant differences exist between the two countries in their mathematical education standards. Chinese students have a higher proportion at the “Understand” and “Master” levels, which may reflect the Chinese education system’s focus on basic knowledge and skills training. In contrast, U.S. students have a significantly higher proportion at the “Comprehend” level, indicating that the U.S. education system may place more emphasis on deep understanding and conceptual mastery, rather than just surface-level knowledge memorization.

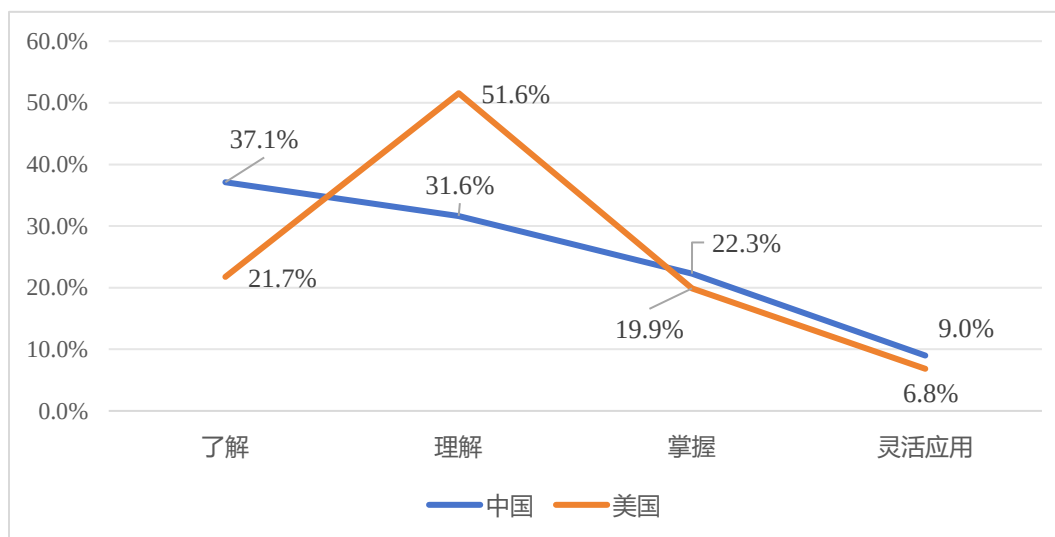


Figure 4. Line Chart Comparing Overall Content Requirements in the U.S. and Chinese Standards

Note: The blue color in the figure represents China, and the orange color represents the United States. The horizontal axis, from left to right, represents “Understand,” “Comprehend,” “Master,” and “Flexible Application.”

5.2.2.2. Multidimensional Analysis

By comparing the content requirements of various fields in the Chinese and American “Standards,” and based on the Chinese “Standard,” the sub-dimensions under the three aspects—“Functions and Equations,” “Algebra and Geometry,” and “Statistics and Probability”—are carefully divided into tables 7 and 8. This facilitates a detailed comparison of the similarities and differences in content requirements across different dimensions of the Chinese and American standards.

Table 7. Content Requirements by Dimension in China

China	Understand	Comprehend	Master	Flexible Application
Function Concepts and Properties	26.3%	47.4%	15.8%	10.5%
Trigonometric Functions	40.0%	30.0%	30.0%	0.0%
Exponential and Power Functions	41.2%	41.2%	17.6%	0.0%
Function Applications	37.5%	12.5%	12.5%	37.5%
Sequences	27.8%	27.8%	33.3%	11.1%
Single-variable Functions and Derivatives	86.7%	6.7%	6.7%	0.0%
Conic Sections	36.8%	21.1%	36.8%	5.3%
Plane Vectors	14.8%	48.1%	29.6%	7.4%
Complex Numbers	55.6%	22.2%	22.2%	0.0%
Introductory Solid Geometry	33.3%	26.7%	26.7%	13.3%
Spatial Vectors and Solid Geometry	29.4%	52.9%	17.6%	0.0%
Probability	43.3%	20.0%	16.7%	20.0%
Statistics	37.8%	35.1%	13.5%	13.5%
Counting Principles	20.0%	20.0%	60.0%	0.0%

Table 8. Content Requirements by Dimension in the United States

United States	Understand	Comprehend	Master	Flexible Application
Concept of Functions	22.6%	64.5%	12.9%	0.0%
Trigonometric Functions	7.1%	57.1%	21.4%	14.3%
Exponential Functions	28.6%	57.1%	14.3%	0.0%
Conic Sections	100.0%	0.0%	0.0%	0.0%
Plane Vectors	38.5%	46.2%	7.7%	7.7%
Complex Numbers	40.0%	26.7%	33.3%	0.0%
Solid Geometry	0.0%	38.5%	30.8%	30.8%
Probability	15.6%	53.1%	21.9%	9.4%
Statistics	17.2%	62.1%	17.2%	3.4%
Counting Principles	0.0%	33.3%	66.7%	0.0%

First, in the dimension of function concepts and properties, as well as specific function models, there are significant differences between the content requirements of the Chinese and American standards. From the perspective of understanding the concept of functions, the Chinese “Standard” tends to focus on understanding and applying functions in real-life contexts, emphasizing the integration of mathematical knowledge with practical problems and cultivating students’ awareness of application and practical skills. In contrast, the American “Standard” places more emphasis on the deep understanding of concepts, guiding students to explore the essence of functions from multiple perspectives, thereby laying a solid foundation for learning different types of functions later. There is not much difference between the two standards in terms of “Understand” and “Master” levels. This discrepancy may arise from the different curriculum setups: in the U.S., linear functions, quadratic functions, and exponential function models are introduced at the high school level, where students first encounter functions. Prior to this, their understanding of functions is limited to rules, variables, and the relationships between linear and nonlinear functions. In China, however, high school students primarily study basic elementary functions like exponentials, logarithms, and power functions, with direct proportionality, linear functions, and quadratic function models being introduced earlier in middle school. The U.S. “Standard” emphasizes understanding functions through multiple representations, such as sequences, application contexts, symbols, and graphs, helping students comprehensively grasp the concept of functions. The Chinese “Standard” also emphasizes real-world applications but places sequences under the elective function section, reflecting a difference in how knowledge is organized. The U.S. “Standard” introduces functions alongside sequences in high school, fostering stronger links between concepts and highlighting the essence of functions. A further comparison of specific function model learning requirements shows that the Chinese “Standard” treats function applications as a separate section, with more balanced requirements for understanding and applying different function types, while the U.S. “Standard” places greater emphasis on students’ deep grasp of function concepts, laying the foundation for later learning. Overall, the Chinese “Standard” emphasizes real-world contexts and flexible application of functions, focusing on developing students’ application awareness and problem-solving abilities.

Second, in the dimension of conic sections, it is evident that the Chinese “Standard” has much higher content requirements for conic sections than the American “Standard.” This is likely because conic sections are relatively abstract and have fewer practical applications, with the U.S. treating them as an extension of knowledge, requiring only an “Understand” level of learning.

Third, in the dimensions of plane vectors, complex numbers, and solid geometry, the Chinese “Standard” demands higher levels of content in plane vectors, focusing more on “Mastery” and “Application” rather than simple “Understanding.” In the case of complex numbers, the content requirements in both the Chinese and American “Standards” are quite similar. However, in solid geometry, the main difference lies in the distribution of levels: the Chinese “Standard” has a more balanced spread across “Understand,” “Comprehend,” “Master,” and “Flexible Application,” whereas the U.S. “Standard” emphasizes higher-level learning, focusing on “Comprehend,” “Master,” and “Flexible Application.”

Fourth, in the dimensions of statistics, probability, and counting principles, the Chinese “Standard” places a higher emphasis on the “Understand” level than the American “Standard.” Both countries have higher requirements for probability than for statistics, with the Chinese “Standard” focusing more on the “Flexible Application” of probability in real-life situations. However, in the probability and statistics dimensions, the U.S. “Standard” has a higher proportion of “Comprehend” level requirements compared to China. In the domain of counting principles, the differences in the proportions across levels are minimal. China’s focus on probability and statistics appears to be somewhat lacking, with emphasis placed mainly on lower-level skills and a corresponding low level of assessment difficulty. In contrast to the U.S., which places greater importance on these areas, the Chinese “Standard” should strengthen students’ higher-level understanding (comprehension, mastery, and flexible application), rather than just focusing on basic problems like identifying probability models and solving problems using nested formulas.

6. Implications

6.1. “Emphasis on Understanding” to Grasp the Depth of Knowledge Learning

From the comparison of the Chinese and American Standards, it is evident that the United States places more emphasis on the depth of knowledge learning. In terms of cognitive level requirements from an overall perspective, the difference between the two countries’ Standards in the “mastery” and “application” levels is not significant, but there is a relatively clear distinction in the “understanding” and “comprehension” levels. In China, many knowledge areas require only an “understanding” level, without reaching the “comprehension” level. “Understanding” is a key term running throughout the American Standards, repeatedly mentioned in its introduction, practical requirements, and content standards. The U.S. curriculum standards emphasize that mathematical understanding, including depth, representation, and problem-solving, is the foundation for mastery and application. This means that, based on understanding, students should be able to reasonably explain a particular mathematical concept, demonstrate that they have grasped the mathematical principles, and use them to solve problems [9]. In this regard, the Chinese Standards can learn from the United States by focusing more on the depth of knowledge learning and refining the standards for mathematical knowledge learning in the “curriculum content” section.

6.2. “Overall Coordination” Focuses on the System and Coherence of Knowledge

The “Mathematics Content Standards” in the American Standards are based on a K-12 learning progression, with a consistent design for kindergarten, elementary school, middle school, and high school. In contrast, China’s curriculum standards are consistently designed for compulsory education (grades 1-9), with a separate design for high school mathematics. This may lead to issues with the continuity of knowledge between middle and high school, as the system and coherence of knowledge are lacking. A curriculum is not just a blueprint for teaching activities; it must be coherent, emphasize key points, and the curriculum content for each grade level should be clearly defined, with the interconnections between mathematical branches explicitly reflected in the curriculum, textbooks, and each lesson. This is an important principle in the American Standards, well-reflected in the “Content Standards” section. For example, in the “High School - Geometry” section, the learning focus for elementary and middle school students is outlined, transitioning from intuitive geometry to rigorous proofs as students’ progress. After entering college, they learn Euclidean geometry and other types of geometry, demonstrating an understanding of the intrinsic connections between different knowledge areas. The “High School - Number and Quantity” section also specifies the process of expanding the number field that students have learned earlier... The Chinese Standards, however, focus more on knowledge within high school and its connections to compulsory education knowledge are mostly reflected in textbook design. This area should be optimized and improved.

6.3. “Focus on Key Areas” Strengthens and Highlights the Main Line

Based on the analysis above, the main divisions for high school in both the Chinese and American Standards are similar, with both falling under the four major areas of “Functions, Geometry and Algebra, Statistics and Probability, Mathematical Modeling,” all having rigorous and logical domain divisions. The “Content Standards” section of the U.S. Standards sets learning priorities and important fields across six major categories, providing an overview of the standards. Readers can quickly grasp the key areas to be learned at the high school level from a macro perspective, while also gaining a detailed understanding of the content and degree

of learning required through the explanation of fields, standards, and groups, achieving the unity of the “two-point theory” and the “key point theory.” Furthermore, through detailed comparison, it can be observed that the U.S. Standards teaching priorities encompass the overall description of concepts, the connections between knowledge, and the foundation of student learning. Although the Chinese Standards list content and class hours distribution according to elective, compulsory, and selective compulsory courses, it lacks a concise summary of important concepts, remaining at the level of broad themes and unit content, without systematically presenting key content. This section could benefit from referencing the U.S. Standards.

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