

# A Quantitative Comparative Study on the Degree of Difficulty of the Curriculum of “Space and Graph” in New Textbooks in China

**Weizhong Zhang**

*Zhejiang Normal University, China*

**Lihong Huang**

*Zhejiang Jinhua Radio & TV University, China*

*Based on the Curriculum Standard, this paper utilized the established model of the degree of difficulty of the curriculum for a quantitative comparison of the content strand “Space and Graphs” in New Textbooks used in China. The analyzed different editions of textbooks here included those published by Zhejiang Educational Press (ZEP), People’s Educational Press (PEP) and East China Normal University Press (ECNUP). . The analytical results showed that: in terms of lesson periods, the PEP edition has more lessons than the other two, out of which, the ECNUP edition has the least lessons. Regarding curriculum width, the ECNUP edition also has the least, and is the only edition that has less width than that of the curriculum standard, and the ZEP edition has more than the other two. Regarding curriculum depth, the ZEP edition is deeper than the PEP edition, which has deeper content than the ECNUP edition. The three editions are all deeper than the curriculum standard. As to the overall difficulty degree, the ZEP edition is of the highest difficulty degree of the three while the PEP edition appears to be the easiest. We argue that this research is both helpful for the compilation of new textbooks and of certain reference significance to the selection of textbooks.*

**Key word:** Space and graphs, difficulty degree of curriculum, quantitative comparison, selection of the textbook

## Introduction

China’s curriculum reform of basic education has not only changed the teaching content of compulsory education, but also changed the textbook. Since the compilers have different understandings of the Mathematics Curriculum Standards for compulsory education, the difficulty degree of the curriculum in textbooks might be different. Geometry is not only the most important content of compulsory education, but also in the most controversial in this round of curriculum reform. So in this study, we will use the model of

difficulty degree of curriculum to compare the editions published by People's Educational Press (PEP), Zhejiang Educational Press, and East China Normal University Press (ECNUP). The Curriculum Standard is the basis during the whole analysis.

### Methodology

Kong (2008) pointed out that curriculum difficulty degree is affected by at least three factors, course time, course breadth and course depth. A Model of Degree of Difficulty of Course has already been established, that is,

$$N = \alpha \frac{S}{T} + (1 - \alpha) \frac{G}{T}$$

$N$  is the course difficulty,  $S$  is the course depth,  $G$  is the course breadth,  $T$  is the course time,  $\frac{S}{T}$  is the constant depth,  $\frac{G}{T}$  is the constant scope, where  $\alpha$  satisfies  $0 \leq \alpha \leq 1$ , known as the weighting factor which shows the degree of the course's focusing on "constant depth" or "constant scope". Thus  $N$  is the weighted average of "constant depth" and "constant scope". In this text  $\alpha = 0.5$ .

Course time refers to time required to complete the course content, which can be quantified by "lesson period". As the *Curriculum Standards* give no provision for lesson periods, the average of the three editions is in statistics. Course breadth, quantified by "knowledge point", is the scope and extent of the areas where course content is involved. Course depth refers to the thinking depth required for course content in general, associated with abstract degree of concepts and mathematical principle as well as the correlation between concepts, which also comes to the reasoning and operating steps of course content that can be depicted by the weighted average of different requirements according to relevant course objectives, that is, the weighted average of knowledge and skill objectives and process objectives. In the *Curriculum Standards*, verbs like "know, understand, master, and apply flexibly" are used to describe the knowledge and skill objectives, while verbs like "undergo, experience and explore" describe the process objectives. Owing to the necessity of quantifying the course depth, the value of each level needs to be assigned in order to distinguish different course depths (Table 1). Exploring and understanding the relevant properties of isosceles trapezoid is referred in the *Curriculum Standards*, where the property of isosceles trapezoid is one knowledge point and its depth is  $(3+1) \div 2 = 2$ , which is the weighted average of knowledge and skill objectives and process objectives.

Table 1

### Value Assignment of Goal Verbs

Knowledge and Skill Objectives	Process Objectives	Value Assignment
know	undergo (feelings)	1
understand	experience (feelings)	2
master	explore	3
Apply flexibly		4

### Result

#### Comprehensive Comparison on Degree of Difficulty of Course

Based on calculating methods of various factors, statistics on the course time, course breadth and course depth, all the content in *Space and Shape* come into being, which leads to the conclusions in Table 2.

Table 2  
Comparison on Course Degree Difficulty of Three Editions

	Depth Level	ZEP Edition of	PEP Edition of	ECNUP Edition of	Curriculum Standards
course time		96	111	89	98.667
course breadth		110	107	95	98
course depth (the number of knowledge points)	1	19	35	35	42
	1.5	18	3	5	1
	2	28	28	22	27
	2.5	23	5	7	1
	3	18	32	22	22
	3.5	4	4	4	5
course depth		2.068	2.037	1.937	1.872
constant scope		1.146	0.964	1.067	0.993
constant depth		0.022	0.019	0.022	0.019
course difficulty degree		0.584	0.491	0.544	0.506

From Table 2, the followings can be seen. Course time: The three editions do not share the same course time. The edition from Zhejiang

Education has 96 lesson periods, the edition from Peoples Education 111 lesson periods and the edition from East China Normal University 89 lesson periods. That is, the average is 98.667 lesson periods, which is the lesson period in the *Curriculum Standards*. Obviously, the edition from Peoples Education has more lesson periods than the other two editions and the *Curriculum Standards*.

Course breadth: The number of knowledge points in the edition from Zhejiang Education is 110, in the edition from Peoples Education 107, in the edition from East China Normal University 95 and 98 in the *Curriculum Standards*. That is, the edition from Zhejiang Education has 3 knowledge points more than the edition from Peoples Education, 15 more than the edition from East China Normal University and 12 more than the *Curriculum Standards*. On the other hand, the edition from East China Normal University has 3 knowledge points less than the *Curriculum Standards*.

Seen from the specific knowledge points, three editions coincide with the *Curriculum Standards*. The points are divided into more specific ones in the edition from Zhejiang Education, while the edition from East China Normal University combines some points. Only the edition from East China Normal University regards Proof as one isolated part, which hasn't been counted separately. However, the other editions distribute Proof into each chapter. Although the similar parts in Proof are excluded, some have already been included in statistics, for example, in the edition from Zhejiang Education, *Reduction to Absurdity* is involved in the chapter of Circle, which is regarded as a knowledge point in statistics.

Course depth: It can be seen that the weighted average of depth level of the Zhejiang Education edition is the highest one and is higher than the other two editions and the *Curriculum Standards*, to a large extent. The weighted average of the edition from Peoples Education is slightly lower than the edition from Zhejiang Education and clearly higher than the *Curriculum Standards*. While the edition from East China Normal University is quite below these two editions and close to the *Curriculum Standards*, all three editions are all higher than the *Curriculum Standards*. According to Snyder's understanding of fidelity of the three orientations in the curriculum implementation, we suppose the expected results of the course reformation are faithful to the original plan. Evaluation of courses is to make sure whether the expected results in course design are achieved or not. In the process of compiling textbooks, the requirements in the *Curriculum Standards* must be put in the first place, which is the basic premise to guarantee the quality of the textbooks<sup>[6]</sup>. This shows from another side that under the new curriculum all the textbooks are based on the *Curriculum Standards*, known as the bottom line.

Course difficulty degree: The edition from Zhejiang Education has the highest course difficulty, which is 15.415 percent higher than the standards.

The edition from Peoples Education is obviously lower than the other two editions and is 2.964 percent lower than the standards. The edition from East China Normal University is between these two editions and is 7.51 percent higher than the standards. Therefore, the edition from Peoples Education fits into the standards most.

## 2. Comparison on Course Difficulty in Each Chapter

From Table 2, it can be seen that each edition differs in course difficulty. Knowing specifically which chapters have relatively large differences benefits the comparison and analysis, thus Table 3 comes into being.

*Table 3*  
**Course Difficulty Degree in Each Chapter**

	ZEP Edition	PEP Edition	ECNUP Edition	Curriculum Standards
preliminary understanding of the graphs	0.681	0.516	0.717	0.616
triangle	0.601	0.473	0.488	0.487
ax symmetric	0.844	0.809	0.806	0.739
translation	1.571	0.725	0.610	0.818
rotation				
quadrangle	0.657	0.582	0.562	0.481
basic nature of circle	0.544	0.628	0.825	0.630
similar triangle	0.636	0.452	0.629	0.602
right triangle	0.432	0.345	0.372	0.326

It can be visualized that there are relatively large differences among the three editions in the course difficulty degree in chapters of translation and rotation. Especially, the ZEP edition is much more difficult than the other two editions and the standards, while the difficulty of both the PEP and ECNUP editions are slightly lower than that of the standards. What's more, the course difficulty degree of ZEP is higher than the other editions and the standards in many chapters, such as the triangle, ax symmetric, quadrangle, similar triangle, right triangle, translation and rotation. The PEP edition is slightly lower than the other editions and clearly lower than the standards in both chapters of preliminary understanding of the graphs and similar triangle. The basic nature of the circle in the ECNUP edition is much more difficult than that in other editions and the standards. As far as the triangle is concerned, both the PEP and ECNUP editions coincide with the standard a lot. When it comes to

similar triangles, both the ZEP and ECNUP editions, but not the PEP edition, coincide with the standard a lot.

## Analysis and Implications

### Analysis of the Result

#### (1) Differences in the depth of knowledge points

*Curriculum Standards* demand more knowing and relatively less understanding for the knowledge points, while all the three editions from the textbooks place more emphasis on understanding rather than knowing. The depth level of most content in the ZEP edition is mainly at 1.5 or 2.5, which result from its higher and clearer demand for process objectives.

#### (2) Differences in arranging the order of the textbooks

While the course difficulty degree of the three editions is largely in accordance with the *Curriculum Standards*, differences still remain. Arranging the order of the textbooks affects course difficulty degree. Take *Space and Shape* as an example; the order of the arrangements is as follows.

The ZEP edition: preliminary understanding of the graphs—triangle—ax symmetric—preliminary understanding of the graphs—triangle—quadrangle—circle—similar triangle—right triangle—circle

The PEP edition: preliminary understanding of the graphs—triangle—quadrangle—triangle—ax symmetric—quadrangle—circle—similar triangle—right triangle

The ECNUP edition: preliminary understanding of the graphs—quadrangle—ax symmetric—triangle—quadrangle—triangle—similar triangle—right triangle—circle

All three editions are arranged in the spiral model and differences exist in the process. For example, preliminary understanding of the graphs is divided into two phases in the ZEP edition. Nevertheless, the PEP placed it in both Part I and Part II of Grade Seven, but there is no other geometric learning between these two parts, thus the preliminary understanding of the graphs in Part II becomes more difficult only to a lesser extent. However, the ECNUP edition arranges all of it in Part I of Grade Seven. The spiral model is not a simple repetition, and the suitable time span also needs to be taken into consideration.

### Implications

Differences exist among the three editions in the course difficulty degree, which can be used to relieve the relatively difficult content of the textbooks by taking course design and textbook compilation into account.

When compiling the textbooks, the spiral model should be appropriately applied, making it neither simple repetition nor decoupling the teaching content. Taking the similar triangle, one of the difficult topic in teaching, as an example, the ZEP edition is the most difficult one and is 41 percent higher than the PEP edition. Thus, the ZEP edition may take the PEP edition as a reference.

Differences exist not only in the course difficulty degree, but also in the educational levels of various localities. Therefore, textbooks can be chosen based on the differences of course difficulty degree, which must be suitable to specific teaching in each area.

### References

- Fan, L. (2006). *Standard mathematics experiment textbook of compulsory education (Grade seven-grade nine)*. Hangzhou, China: Zhejiang Education Press.
- Institute of Teaching Materials. (2004). *Standard mathematics experiment textbook of compulsory education (Grade Seven-Grade Nine)*. Beijing, China: Peoples Education Press.
- Kong, F. (2008). *Exploration of the research methods of textbook quality*. Beijing, China: Peoples Education Press, 75-86.
- Ma, Y. (2003). *Curriculum and teaching theory*. Beijing, China: Central Radio and Television University Press, 145.
- Ministry of Education of the People's Republic of China. (2001). *Mathematics course standards of full-time compulsory education (experiment draft)*. Beijing, China: Beijing Normal University Press.
- Wang, J. (2004). *Standard mathematics experiment textbook of compulsory education (Grade Seven-Grade Nine)*. Shanghai, China: East China Normal University Press.

### Authors:

Weizhong Zhang  
Zhejiang Normal University, China  
Email: lzzwz@zjnu.cn

Lihong Huang  
Zhejiang Jinhua Radio & TV University, China  
Email: huanglihong@yahoo.com.cn