Alignment Between the Curriculum Standards and Mathematics Academic Proficiency Test in Junior Middle School

Huanxia Wang[1,2]

(1. School of Education, Qufu Normal University, Qufu, Shandong 273165,China; 2. Chinese Academy of Education Big Data, Qufu, Shandong 273165, China)

Cuixia Zhang

School of Education, Qufu Normal University, Qufu, Shandong,273165,China

Ge Qin

School of Education, Qufu Normal University, Qufu, Shandong 273165,China

Yu Liu

School of Education, Qufu Normal University, Qufu, Shandong 273165,China

Jiqiang Jiang

School of Mathematical Science, Qufu Normal University, Qufu, Shandong,273165,China

Yachun Li

Fujian net dragon computer network information technology Co., Ltd.

Abstract. In the background of education reform based on curriculum standards, it is of great theoretical and practical value to study the consistency of academic evaluation and curriculum standards. In this paper, the Surveys of Enacted Curriculum model is used to analyze the alignment of the mathematics academic proficiency test and the mathematics curriculum standard in junior high school. The results show that the consistency coefficient between the test paper and the content standard is 0.5825, and there is no significant consistency statistically. Compared with the curriculum standards, there are some deviations between the content themes and the cognitive level of the academic proficiency test paper in junior high school. On the content themes, the test paper has intensified the examination of "Graphic Changes", "Equations and Inequalities", "Sampling and Data Distribution" and "Probability of Events". In terms of cognitive level, the test paper has increased the strength of "Grasp", and reduced the strength of “Know”, “Understanding” and “Apply”. It is suggested that we should further improve the mathematics curriculum standard and set up a scientific evaluation standard for mathematics academic level, so as to achieve a good match of mathematics academic proficiency test and curriculum standard.

Keywords: Alignment， Curriculum Standards， Mathematics Academic Proficiency Test

Introduction

Correspondence to: Wang Huanxia; e-mail:wanghx_21cn@163.com

In 2001, the Ministry of Education promulgated The Basic Education Curriculum Reform Outline (Draft) (hereinafter referred to as The Outline), marking our country has entered a phase of the new curriculum reform (Ministry of Education of the People's Republic of China,2001). The purpose of the new curriculum reform is to build up basic education curriculum system to meet the requirements of quality education in the 21st century . But in our country, academic evaluation is always the key bottleneck of curriculum reform , also the important shackles of quality education implementation. The background of national new curriculum reform provides broad space and suitable soil for curriculum evaluation especially academic evaluation, and promotes the recognition and understanding of curriculum researchers' on the consistency between academic evaluation and curriculum standards.

The curriculum standard is a programmatic document to determine the level of the curriculum, the structure of the course and the model of the course in a certain stage of school education (Mingyuan Gu,1998). The Outline stipulates that the curriculum standards are the basis for the teaching material compilation, teaching, evaluation and examination. And the curriculum standards stipulate the basic quality of a country in a certain area or field and the nature, objectives and content framework of each course, and put forward suggestions for teaching and evaluation(Ministry of Education of the People's Republic of China,2001). With regard to the composition of curriculum standards, there are three types of standards, such as content standards, performance standards and opportunity-to-learn standards. In three types of curriculum standards, content standards is the basis of curriculum standard. It specifies what students should know and what they can do, or what knowledge and skills they should master. The content standards usually describes the knowledge and skills expected of the students according to the grades. In terms of curriculum standards currently implemented in China, it is mainly a mixture of content standards and performance standards, and there is no specific performance standard for students in each discipline. The successful implementation of curriculum standards should be standardized, clear, and accords with the curriculum contents of physical and mental development of primary and secondary school students in China. There is also a series of evaluations that match them to detect the implementation of standards.

The Ministry of Education's Opinion on Deepening and Further Improving the Reform of the Middle Examination points out that "establishing the evaluation and examination system suitable for the new curriculum is the key system to implement quality education"(Ministry of Education of the People's Republic of China,2008). With the continuous improvement of curriculum standards, whether the way of academic evaluation conforms to the requirements of the curriculum standard has become a hot research topic for educators(Yunhuo Cui, Shaofei Wang,2008). The junior high school students' academic proficiency test in China is the last test in the nine-year compulsory education stage. The purpose is to assess comprehensively and accurately whether junior middle school students can achieve the academic level stipulated in the curriculum standards in compulsory education stage. The junior middle school students' academic proficiency test is regulated by the state. In different regions, the local level academic level examination policy is formulated according to the actual situation and development of the local area. Therefore, it presents diversity and local characteristics in the nature, function, form and difficulty of the examination (Min Cai, 2006). It is not only an examination of the knowledge of the students in junior middle school, but also an important means of testing the cognitive levels of the students at this stage (Xinyong Lei, 2010). To analyze whether it has consistency between the academic proficiency test and curriculum standards not only can detect the implementation of curriculum standards in the teaching, but also can help educators better understand the relationship between curriculum standards, academic evaluation and instruction and make better use of curriculum standards to guide teaching.

The research on the consistency of academic evaluation and curriculum standards originated in the United States. In 1965, the United States began to require schools to use national norm-referenced tests under the aid of the US Department of Education. However, due to ignoring whether the test is consistent with the curriculum standard, it leads to the fact that the norm-referenced test can not provide enough information to reflect students' knowledge and skills. Therefore, developing the model of consistency analysis between academic evaluation and curriculum standards has become an important subject in the field of basic education in the United States. In 1998, the United States established the Association for the Consistency Analysis of Curriculum and Evaluation. The Association pointed out that the evaluation should be consistent with the curriculum standard, and should provide continuous information about students' academic achievement based on curriculum standards. The consistency of evaluation, curriculum and teaching should be regarded as a key indicator of the effective implementation of curriculum standards by states, communities and schools (U.S. Congress House of Representatives,1994). Under the support of the United States government, the states have conducted studies and experiments on the consistency of academic evaluation and curriculum standards. In this context, a number of consistency analysis models have been developed in the United States. Different methods of consistency analysis have their own research focus, and they have advantages and disadvantages when applied to specific situations. Among all these methods, Webb consistency analysis mode（Webb, N. L., 1999）, SEC consistency analysis mode（Porter,A. &Smithson,J. 2001）and Achieve consistency analysis mode（Xiufeng Liu, Baohui Zhang etc. , 2008）are more famous and widely used. In addition, Webb consistency analysis mode and SEC consistency analysis mode are used for reference by Chinese scholars.

From the perspective of literature, the research on the consistency of all elements in the curriculum started relatively late in China. There are few academic papers on this aspect, and the related research is mainly focused on introducing and summarizing the achievements of foreign scholars. Yunhuo Cui's research has been carried out from the aspects of international comparison, the consistency of the two elements, the standard-based propositions and the quality detection of education. And his quantitative research on the relationship between curriculum standards and evaluation, and the measurement of test questions based on the curriculum standards gave an operational research conclusion (Yunhuo Cui, Shaofei Wang,2008). In the research of standard-based curriculum reform of American basic education, Xia Chen (2004) made a comprehensive introduction to the evaluation characteristics and current situation of the United States as well as the implementation strategies of the performance evaluation in teaching and the progress in the research on consistency. The first study of the consistency between curriculum standard and evaluation in China is The Construction of Consistency Between Evaluation and Curriculum Standards: American Experience, published by Xuezhi Liu (2006). He introduced the United States' research on the consistency of evaluation and curriculum standards.

Analyzing Methods and Analyzing Process

1. Analyzing Methods

The alignment analysis paradigm refers to the sum of ideas, procedures and methods that judge and analyze the degree of consistency between the various elements of the course system (Norman,L.Webb,1999). This research will adopt the consistency analysis tool developed by Andrew Porter) and John Smithson, namely "SEC" consistency analysis mode, to study the consistency between academic evaluation and curriculum standard.The specific steps of "SEC" consistency analysis model are: first set up the analysis framework, that is, the two dimensional framework of content themes and cognitive requirement; and then establish the analysis standard of the content themes and the cognitive requirements based on expert consultation and other ways; Finally, the degree of consistency between the curriculum standards and the evaluation project is measured in accordance with the

matching degree of the curriculum standards and the evaluation project. Therefore, first of all, we need to transform curriculum standard and test paper into two dimensional coding matrix of the same format. One dimension is content themes, the other is cognition level. Then, all the data in the table are standardized, and two ratio forms are formed. Then the cell value is put into the consistency P value formula, and the consistency coefficient P is gotten. The greater the P value is, the better the consistency level will be.Finally, the P and the critical value are compared to get the conclusion whether the test paper is consistent with the curriculum standard (Webb N L., 1999).

The formula for calculating the consistency coefficient:

$$P = 1 - \frac{\sum_{i=1}^{n} | X_i - Y_i |}{2}$$

In this formula, P represents the consistency coefficient, n represents the number of cells in the matrix, and X*i* and Y*i* respectively represents the values corresponding to the *i* cell in the evaluation project analysis matrix and the content standard analysis matrix. The range of the consistency coefficient P values is 0 to 1. P=0 indicates that the consistency between evaluation items and curriculum standards is the worst, that is, they are totally inconsistent. P=1 indicates that the evaluation items and curriculum standards are exactly the same in the distribution of knowledge content and depth (X.F.Liu, B.H.Zhang, L .Ling, Gavin Fulmer, Beaumie Kim, H. Q. Yuan.,2008).

2. Analyzing Process

The curriculum standard referred to in this paper is The Compulsory Education Mathematics Curriculum Standard (2011) formulated by the Ministry of Education of People's Republic of China (hereinafter referred to as "Curriculum Standard") (Ministry of Education of the People's Republic of China, 2011). This is the latest version of the curriculum standard in our country. In addition, this study is based on the mathematics academic proficiency test paper in W city in 2015. Considering the reality of this research object, we first need to appropriately divide the content themes dimension and the cognitive levels dimension, and identify the consistency analysis framework of this research. Then we independently code the curriculum standard and the math test questions in two dimensions of content themes and cognition level, and then do data statistics. The statistical results are aggregated into the framework of consistency analysis and converted into a ratio table. According to the data obtained in the ratio table, the Porter consistency coefficient is calculated. Next, the analyzation is carried out from the overall consistency level of the two aspects, the consistency level of content subject and the consistency level of cognition level, and the corresponding conclusions are drawn. Finally, the advice is put forward according to research results.

2.1 The Classification of Content Themes and Cognitive Levels

The curriculum standard of junior middle school involves four fields of learning: "Number and Algebra", "Graph and Geometry", "Statistics and Probability" and "Integration and Practice". Due to the fact that "Integration and Practice" is a combination of practical scenarios to design solutions and reflection process, it is not easy to quantify. So it is not in the scope of this research. The content themes in the remaining three learning areas are shown in Table 1.

Table 1 The Content Themes of the Mathematics Curriculum Standard

Number and Algebra	Graph and Geometry	Statistics and Probability

Number and Formula	Graphic Properties	Sampling and Data Distribution
Equation and Inequality	Graphic Changes	Probability of Events
Function	Graphics and Coordinates	
3	3	2

According to the newly revised Bloom taxonomy (Anderson & Krathwohl, 2001) and the division and interpretation of the cognitive levels in the Curriculum Standard, we divide the cognitive levels into the following 4 categories, as shown in Table 2.

Table 2 Knowledge Depth Level and Examples

Level	Knowledge Depth Level	Interpretation	Action Verbs	Examples
1	Know	The characteristics of an object from a specific instance or exemplified by an example; The object is identified or exemplified from the specific situation according to the characteristics of the object.	Know, Preliminary know	Know the inner center and external center of the triangle; Preliminary know the decimal and fraction with specific situations
2	Understand	Describe the characteristics and origin of the object, and explain the difference and connection between the object and the related object.	Identify	Identify a triangle
3	Grasp	The object is used in a new situation on the basis of understanding.	Can	Can recognize, read and write the number within ten thousand; Can use the number to represent the order and position of an object
4	Apply	Use the object that has already mastered, choose or create the appropriate method to solve the problem.	Prove	To prove a theorem: the two sides of the triangle are equal, and the angle of the two sides crossing is equal,then the two triangles are congruent.

Therefore, the matrix of content standards and test paper is a 8 * 4 table.That is, 8 content themes and 4 cognitive skills. The 8 content themes are "Number and Formula", "Equation and Inequality", "Function", "Graphic Properties", "Graphic Changes", "Graphics and Coordinates", "Sampling and Data Distribution", "Probability of Events". The 4 cognitive levels are "Know", "Understand", "Grasp" and "Apply".

2.2 Coding of Content Standard and Test Paper

2.2.1Coding of Content Standard

In order to ensure the reliability of the study, three encoders first independently encode the content themes. The coder assigns each cell as the measurement unit in the matrix according to the knowledge item in the content standard , and obtains the results of each analysis. The correlation coefficient of 3 coding results was 0.947 ($P < 0$),

indicating good internal consistency for the coding results of the content standard.Where the code is different, the coders reach an agreement through discussion and negotiation to form the final results, as shown in Table 3.

Table 3 Distribution of the Number of Content Themes and Cognitive Levels in the Analysis Frame in the Content Standard

	Know	Understand	Grasp	Apply	Sum
Number and Formula	11	22	19	0	52
Equation and Inequality	2	3	13	0	18
Function	4	7	15	0	26
Graphic Properties	25	25	25	16	91
Graphic Changes	16	10	5	1	32
Graphics and Coordinates	4	2	6	0	12
Sampling and Data Distribution	5	3	7	0	15
Probability of Events	2	1	1	0	4
Sum	69	73	91	17	250

In order to compare with the coding matrix of the test paper, Table 3 is standardized, as shown in Table 4.

Table 4 Distribution of the Ratio of Content Themes and Cognitive Levels in the Analysis Frame in the Content Standard

	Know	Understand	Grasp	Apply	Sum
Number and Formula	0.044	0.088	0.076	0.000	0.208
Equation and Inequality	0.008	0.012	0.052	0.000	0.072
Function	0.016	0.028	0.060	0.000	0.104
Graphic Properties	0.100	0.100	0.100	0.064	0.364
Graphic Changes	0.064	0.040	0.020	0.004	0.128
Graphics and Coordinates	0.016	0.008	0.024	0.000	0.048
Sampling and Data Distribution	0.020	0.012	0.028	0.000	0.060
Probability of Events	0.008	0.004	0.004	0.000	0.016
Sum	0.276	0.292	0.364	0.068	1.000

2.2.2 Coding of Test Paper

For the examination paper, to determine exactly what content and knowledge level is examined in the examination paper is of great importance to the reliability of this study. Three encoders respectively use content analysis (Xiaowei Yang, 2005) to analyze the content themes and cognitive levels of the test paper. To increase objectivity,

first determine which main points is examined in a test item (more detailed than the content themes).Then by refining the process of solving the problem, find out the point of score, and determine the cognitive levels that the students need to achieve when they solve the problem. According to the order of the test items, the scores of content themes and cognitive levels examined in each test items are filled into the "Content Themes * Cognitive Levels" coding matrix. Then the value of of each cell in the matrix is counted. Then the sum of each content subject and cognitive level is counted, and the distribution of the data in the analysis framework is obtained. After calculation, the internal consistency reliability coefficient of the results is 0.910, which shows that the research has good internal consistency. Where the code is different, the coders reach an agreement through discussion and negotiation to form the final results, as shown in Table 5.

Table 5 The Distribution of the Scores in the Analysis Frame in the Test Paper

	Know	Understand	Grasp	Apply	Sum
Number and Formula	0	7	16	0	23
Equation and Inequality	0	0	12	0	12
Function	4	0	7	0	11
Graphic Properties	0	0	17	3	20
Graphic Changes	15	14	9	0	38
Graphics and Coordinates	0	0	3	0	3
Sampling and Data Distribution	2	0	7	0	9
Probability of Events	0	0	4	0	4
Sum	21	21	75	3	120

In order to compare with the coding matrix of the content standard, Table 5 is standardized, as shown in Table 6.

Table 6 Distribution of the Ratio of Content Themes and Cognitive Levels in the Analysis Frame in the Test Paper

	Know	Understand	Grasp	Apply	Sum
Number and Formula	0.000	0.058	0.133	0.000	0.192
Equation and Inequality	0.000	0.000	0.100	0.000	0.100
Function	0.033	0.000	0.058	0.000	0.092
Graphic Properties	0.000	0.000	0.142	0.025	0.167
Graphic Changes	0.125	0.117	0.075	0.000	0.317
Graphics and Coordinates	0.000	0.000	0.025	0.000	0.025
Sampling and Data Distribution	0.017	0.000	0.058	0.000	0.075
Probability of Events	0.000	0.000	0.033	0.000	0.033
Sum	0.175	0.175	0.625	0.025	1.000

2.3 Calculate Pat Consistency Coefficient and Compare with Critical Value

The data in the test paper and the data in the content standard are put into the Pat consistency coefficient formula, and the consistency coefficient of the test paper and the physical content standard is obtained. At this time, n=32.

To determine whether there is significant consistency between test paper and content standard, we can draw a conclusion by comparing the consistency coefficient obtained with the corresponding critical value. The research shows that for the 8 * 4 matrix, in case of the bilateral test, the critical value of the consistency coefficient corresponding to the 89 "standard points" is 0.8648 in order to achieve significant consistency at the 0.05 level (Fulmer, G. W. , 2011).

2.4 Draw Topographic Maps and Histograms for Further Comparison and Analysis

Because the Pat consistency coefficient only uses the total standard deviation, it shows the absolute difference between the test paper and the content standard. It is not clear whether the proportion of the content themes of the test paper are larger than those in the content standard, and whether the cognitive levels of the test paper are higher than those in the content standard. In order to facilitate further comparative analysis, the researchers draw the data from the matrix into topographic maps and histograms, from which we can clearly see what themes are relatively focused on the content and what levels are relatively concentrated in the cognition.

Results and Discussion

1.The Overall Comparison of the Consistency between the Content Standard and the Test Paper

In order to compare the consistency between content standard and test paper as a whole, we use topographic map to express the weight of different content themes and cognition levels in the content standard and the the test paper , as shown in Figure 1.Observing the left and right diagrams in Figure 1, we can see that the overall distribution of content standard topographic map and test paper topographic map is quite different, indicating that they do not have significant consistency.

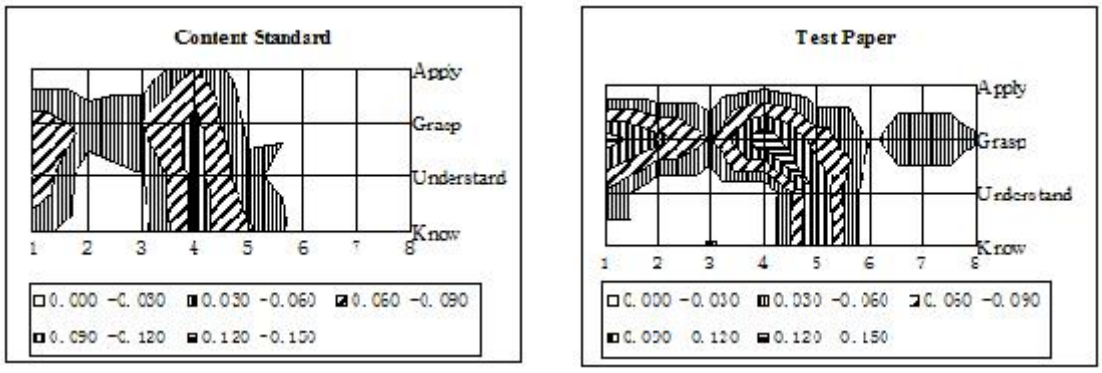

Figure 1 Comparison of the Topographic Map of the Content Standard and the Test Paper

Note: The number 1-8 in the horizontal ordinates of the two graphs in Figure 1 are respectively expressed: “Number and Formula”、“Equation and Inequality”、“Function”、“Graphic Properties” “Graphic Changes” “Graphics and Coordinates” “Sampling and Data Distribution” and “Probability of Events”.

According to the data in the topographic map of the content standard and Table 4 , it can be seen that the content standard pays more attention to Graphic Properties (Know, Understand and Apply), Number and Formula (Understand and Apply), Graphic Changes (Know) and Function (Apply). Second, it attaches importance to Equation and Inequality (Grasp), Sampling and Data Distribution (Grasp), Graphics and Coordinates (Know) and Probability of Events (Know). From the data in the topographic map of the test paper and Table 6 , it can be seen that the focus of the test paper is on Graphic Changes (Know and Understand), Number and Formula (Grasp), and Graphic Properties (Grasp). Second, it concentrates on Equation and Inequality (Grasp), Function (Grasp), Sampling and Data Distribution (Grasp), Probability of Event (Grasp) and Graphics and Coordinates (Grasp).

The data in Table 4 and Table 6 are put into the consistency coefficient formula, and the consistency coefficient between the test paper and the content standard is 0.5825, which is lower than the critical value of 0.8648, indicating that there is no statistically significant consistency between the test paper and the content standards.

2.A Comparison of Content Themes between Content Standards and the Test Paper

The data in Table 4 and Table 6 are expressed in the form of a histogram, showing the comparison of the content themes between the content standard and the test paper, as shown in Figure 2.

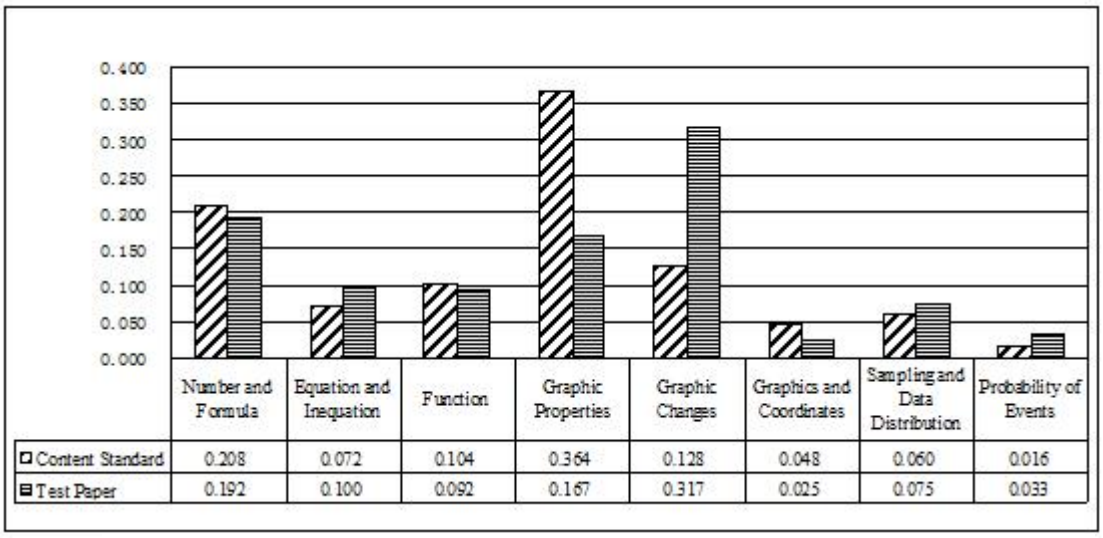

Figure 2 Comparison of Content Themes of Content Standards and Test Paper

Compared with the content standards, there is a deviation in the focus of the test paper on the content themes. The proportion of the number of knowledge points in the content standard is as follows: Number and Formula(0.208), Equation and Inequality(0.072), Function(0.104), Graphic Properties(0.364), Graphic Changes(0.128), Graphics and Coordinates(0.048), Sampling and Data Distribution(0.060) and Probabilities of Events(0.016). But the proportion of the score of the content themes in the test paper is as follows: Number and Formula(0.192), Equation and Inequality(0.100), Function(0.092), Graphic Properties(0.167), Graphic Changes(0.317), Graphics and Coordinates(0.025), Sampling and Data Distribution(0.075) and Probabilities of Events(0.033).

It can be seen that compared with the content standard, the test paper has intensified the examination of "Graphic Changes", "Equations and Inequalities", "Sampling and Data Distribution" and "Probability of Events". At the same time, the test paper reduces the strength of the "Graphic Properties" and "Graphics and Coordinates".

For "Number and Formula" and "Function", the proportion of the score in the test paper is basically the same as the proportion of the number of knowledge points in the content standard.

3.A Comparison of the Cognitive Level Distribution between the Content Standard and the Test Paper

The data in Table 4 and Table 6 are expressed in the form of a histogram, and the cognitive level of the content standard and the test paper is compared, as shown in Figure 3.

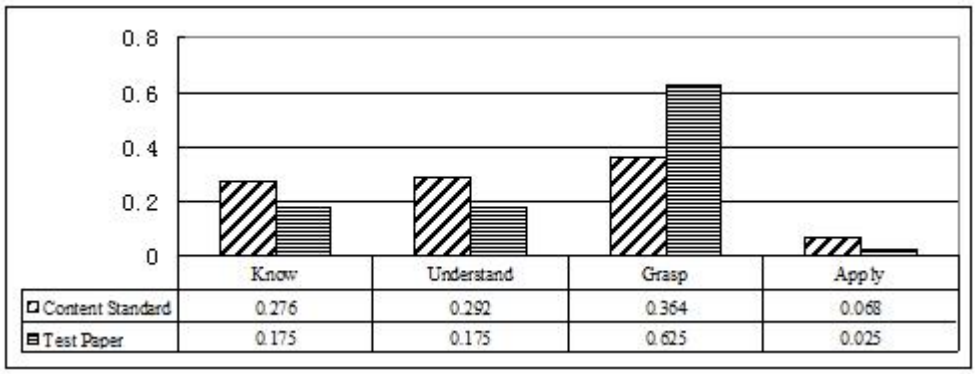

Figure 3 A Comparison of the Cognitive Level of the Content Standard and the Test Paper

As can be seen from Figure 3, there is a great difference in the distribution of cognitive level between the content standard and the test paper. The proportion of knowledge points to all levels of cognitive level in the content standard is as follows: Know(0.276), Understand(0.292), Grasp(0.364) and Apply(0.068). But the proportion of the score of the cognitive level in the test paper is as follows: Know(0.175), Understand(0.175), Grasp(0.625) and Apply(0.025). This shows that the test paper has increased the strength of "Grasp", and reduced the strength of “Know”, “Understanding” and “Apply”.

In summary, we can see that in terms of content themes, the content standard emphasizes the “Graphic Properties”, “Number and Formula” and “Graphic Changes”, but the test paper emphasizes “Graphic Changes”, “Number and Formula” and “Graphic Properties”. In terms of cognitive level, the content standards emphasize “Grasp”, “Understanding” and “Know”, but the test paper emphasizes “Grasp”. So, in general, the content standards and test paper do not have statistical consistency.

Implications

The junior high school math proficiency test, as a course based on the curriculum standards, should be consistent with the mathematics curriculum standards. But this study shows that there is no statistical consistency between the junior high school math test and the mathematics curriculum standards in W city. The disagreement between the academic level examination and the curriculum standards will be disadvantageous to the full implementation of the teaching objectives and the professional development of the teachers. Therefore, it is necessary for us to achieve the consistency of the academic proficiency test and the curriculum standards by improving the curriculum standards and establishing a scientific standard of evaluation.

4.Improving the curriculum standard and increasing the performance evaluation standard

Our curriculum standards only has content standards, so we should develop performance evaluation standard, making the evaluation at all levels has "conclusive evidence" to refer to. If the proposition merely rely on a broader content standard , the consistency between the test paper and the curriculum standard depends largely on the degree of the familiarity of the content standard and teaching materials of junior middle school that the propositional person keep (J Scheerens., 2017). If the propositional requirements of junior high school mathematics teaching and learning are not accurately understood enough, the relevant content in high school is "deformed" as test items. It is bound to lead to more and more difficult topics, more and more deviating from the cognitive level of junior high school students, thus bringing incorrect guidance to the mathematics teaching in junior middle school.

5.Develop evaluation methods variously , and build scientific academic evaluation standard

Some of the specific goals in the curriculum standards are not suitable for paper and pen tests, and some of them belong to the process goals, such as realize, experience and explore, etc. This is the feature of the new curriculum standard, but these can not be examined in the test paper, so we should adopt a diversified evaluation method instead of the traditional single paper and pen test.(Michael D.Beck，2007).

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