Alignment Between Physics Curriculum Standard and High School Physics Exit Examination in China: A Comparison among Guangdong, Ningxia, Shandong, and Hainan Provinces

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In order to find out if the physics achievement qualifying examination reflect the main contents of physics curriculum standards and the direction of the curriculum reform, this study compares the alignment between the physics curriculum standard of senior high school in China and physics achievement qualifying examination in Guangdong, Ningxia, Shandong and Hainan provinces. The results based on the Porter alignment method indicate that all the alignment between curriculum standard and test papers in the four provinces are very low, with the Porter alignment index range from 0.25 to 0.38, due to a shift toward higher cognitive level from curriculum standard to exams and the focus of the exam contents in mechanics. Although the experimental inquiry and physics history are paid attention to in all these test papers, no PTS (physics-technology-society) and physics ideas and methods are reflected in these papers at all. How to test these aspects, which are important contents in the new physics curriculum, remains to further research.

I. INTRODUCTION

Since the 21st century, a new educational curriculum reform has been carried out in China mainland. The new compulsory education curriculum standards were issued in 2001, which include a two year physics course and a three year science course for junior middle school students. The new curriculum standards for senior high school were issued in 2003, which emphasizes modernization, basis and selectivity. In order to give more autonomy to the students, the new physics curriculum standard for senior high school designed two compulsive modules and three selective series (see figure 1), and each module holds 36 credit hours or 2 credits. Every student is required to take 3 modules at least, i.e. 108 credit hours or 6 credits. The two compulsive modules are held in grade one of senior high school, taking Newton's mechanics as the main contents. From senior two, there are three series of modules for students to choose. Series 1, designed for liberal art majors, includes two modules emphasizing physics connecting with daily life and society. Series 2 mainly talks about application of physics in technology, however, there are few students choosing series 2 due to the limitation of examination, teacher preparation and lack of teaching equipment. Series 3 is designed to help students to learn more physics and prepare for the entrance of science and technology in higher education. It comprises five modules, focusing on the basic knowledge, physics idea and methods, helping students to have deep understanding of the application of physics in technology and the effect of physics on economic and society.

The reform of senior high school curriculum began in 2004, with Guangdong, Ningxia, Shandong, and Hainan as the first experiment provinces. To some degrees, these four provinces represent the different level of social economic and educational development in China mainland. By the end of 2009, there are in total 24 provinces joining the reform, and it is planned to extend to national range by the year

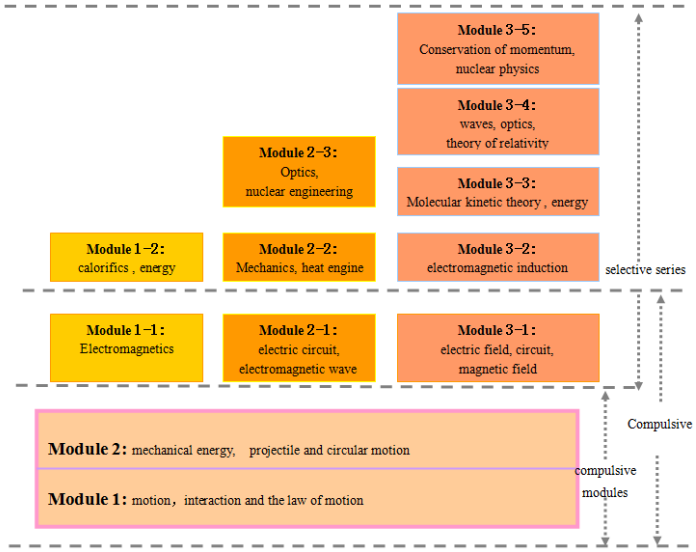

Figure 1. The structure of the new physics curriculum standard for senior high school

2012. With the progress of curriculum reform, the system of assessment is changing, too. The senior high school exit exam has taken the place of the senior high school achievement qualifying examination. Physics qualifying exam is a provincial responsibility, being held one or two times each year, and it mainly focuses on the content of compulsive modules and the elective module 1-1 according to the curriculum standard. Different provinces have different examinees, for example, physics exam is designed for all students in Shandong and Ningxia province, and it's just for liberal arts students in Guangdong and Hainan province. What's more, in some provinces students must pass the qualifying exams before graduating from senior high school and joining the National College Entrance Examination, so it's also a kind of high-stakes standardized test.

In recent years, international science education researchers have begun to pay attention to the alignment be-

tween curriculum and high-stakes test, especially the content standards (Bhola, Impara, & Buckendahl, 2003; Porter, 2002; Porter, Blank, & Zeidner, 2007; Webb, 2007; Horn & Kincheloe, 2001; Sunal & Wright, 2006). This is because, when content standards and high-stakes standardized tests are aligned, science instruction can be expected to align with content standards, as well as other components of the education system such as professional development (Herman & Webb, 2007). Rothman in his review pointed out that overall the alignment between state standards and standardized tests is poor (Rothman, 2003). However, his conclusions contradict with the reported alignment by states and test publishers (Wixson, Fisk, Dutro, & McDaniel, 2002, as cited in Rothman, 2003), which is likely due to different alignment criteria and methodology used.(Bhola et al., 2003; Rothman, 2003).

In this study, we pay attention to the alignment between curriculum and high-stakes test in China, and we choose senior high school physics qualifying exam papers from Guangdong, Ningxia, Shandong, Hainan provinces in 2009, using quantitative methods to analyze the alignment between these test papers and physics curriculum standard, which can help us to find out whether these papers reflect the main contents of curriculum standards and the direction of reform or not. Further more, what we have found will give references and research base to the improvement of assessment and the physics curriculum reform.

II. RESEARCH DESIGN

In this paper, we adopt the Porter alignment analyzing method according to Liu's report, which will make our research result more comparable with other researches.

A. Porter alignment method

Porter alignment method uses the index P to reflect the alignment between curriculum standards and the test papers, and P is range from 0 to 1, with 0 meaning a maximal discrepancy and 1 a perfect agreement between the content standard and the standardized test. The Porter alignment index (P) is defined as follows:

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

where n is the total number of cells in the table and i refers to a specific table cell, ranging from 1 to n. For example, for a 13 × 5 table, there are 65 cells, thus n = 65. X_i refers to the ith cell of Table X (e.g., the content standard table) and Y_i refers to the corresponding cell (ith cell) in Table Y (e.g., the standardized test table). Both X_i and Y_i are ratios with a value from 0 to 1. The sum of X_1 to X_n is equal to 1, so is the sum of Y_1 to Y_n. The discrepancy between the ith cells of the test table and the standard table can be calculated as $X_i - Y_i$. The total absolute discrepancy is then calculated by summing the absolute discrepancies.

Because cell values of two random tables may result in a certain degree of alignment, it is necessary to find out how high an alignment index needs to be in order for us to claim it statistically significant. Using Microsoft Office Excel, we created an algorithm to randomly place curriculum standards and test ratio (each summation is 1) into two tables (thirteen rows and five columns; see explanations in the next section) and determine alignments between each pair of tables. Multiple iterations were conducted, each with 1,000 alignment measures calculated. This yielded a normal distribution with mean of 0.666 (SD = 0.034), stable across all iterations. Based on the random sampling distribution obtained from this algorithm, an alignment of 0.720 is needed in order for it to be statistically significant at the 0.05 level.

B. The analysis framework

Based on the Chinese physics curriculum standard of senior high school, we defined knowledge content categories and cognitive skills which formed the analysis framework.

The knowledge content included all the contents in compulsive module 1, compulsive module 2 and selective series module 1-1. The categories are the main topic of the modules and each topic includes a list of specific subtopics as follows:

Compulsive module 1 and 2:

1. description of motion: mass point, displacement, velocity, acceleration, linear motion with constant acceleration
2. interaction and the law of motion: sliding friction, static friction, Hooker's law, composition and resolution of forces, Newton' s second law
3. mechanical energy and power source: work, power, kinetic energy, the law of kinetic energy, gravitational potential energy, conservation of energy
4. projectile motion and circular motion: projectile motion, circular motion with constant speed, centripetal acceleration, centripetal force
5. the achievement and limitation of classic mechanism: the law of gravity, circular velocity of satellite, the achievement and limitation of classic mechanism

Selective module 1-1:

6. electric field: static electricity, interact between charges, electric field
7. magnetic field: magnetic field, Ampere force, Lorentz force
8. circuit: resistor, capacitor, inductance, family circuit
9. electromagnetic induction: the law of electromagnetic induction, electromagnetic induction and the development of society
10. household electric appliances：safety utilization of electric power

The history of physics, PTS, physics ideas and methods, all of these aspects are paid more attention in the new physics curriculum compared to the former syllabus; therefore, we list the requirement of them according to the curriculum and add it into the content categories as follows.

11. physics history: the important issues in the history of physics, physicists and their contribution
12. physics, technology and society: the interaction of physics , technology and society, practicability of physics
13. ideas and methods: ideas and methods of physics

There are four cognitive skill levels required in the new physics curriculum as bellows:

1. remember: recall, identify fact or evidence, give examples, describe the basic character of object
2. recognize: between remember and understand
3. understand: grasp the internal logic connection, make connection between knowledge, explain, deduce, distinguish, extent; give evidence; collect and process information
4. apply: use abstract conception and principle in new context

Scientific inquiry and physics experimental ability are also emphasized in the new physics curriculum, so we put them together as experimental inquiry and add it to the cognitive skill. Therefore, our analysis framework consists of 13 content categories and 5 cognitive skill levels. Accordingly, the matrix for coding content standards and tests is 13×5 table. (Table 1)

III. RESULTS AND ANALYSIS

A. Analysis of physics curriculum standard

According to the category and cognitive skill, we counted each item in module 1, 2 and module 1-1 of the physics content standard and put the sum number in the cell of table 1 which shows the distribution of the content among the main topics and cognitive skills. In order to compare with the text matrix, we divided each cell value by the total number (i.e. 110) and then obtained the standardized curriculum table with cell values to be ratios as shown in table 2.

Topographies are used to represent relative emphases among different topic areas and cognitive skills in a content standard or a standardized test. In these topographies, blue areas indicate a minimal emphasis (ratio below 0.02, or 2%), red areas indicate a less emphasis (ratio between 0.02 and 0.04, or 2%–4%), yellow areas indicate a middle emphasis (ratio between 0.04 and 0.06, or 4%–6%), green areas indicate the more emphasis (ratio between 0.06 and 0.08, or 6%–8%), and purple areas indicate the most emphasis (ratio between 0.08 and 0.1, or 8%–10%).

As we can see in Table 2, the contents taking relatively larger proportion are that about interaction and the law of motion (13.5%), mechanical energy and power source (12.6%), physics-technology-society (15.3%), and physics ideas and methods (11.7). The first two topics are the traditional emphases of physics teaching in high schools. The PTS and physics ideas and methods reflected the new curriculum emphases.

When it comes to the cognitive skill, as shown in Table 2, the cognitive level for most contents are remember (45%), next are recognize (15.3), understand (15.3) and experimental inquiry (14.4), then apply takes the lowest ratio (9%), and there is no higher cognitive level than apply. It is expressing such reform ideas: physics for all, extending students' range of knowledge, pay more attention to experimental inquiry, and reduce the difficulty of physics curriculum.

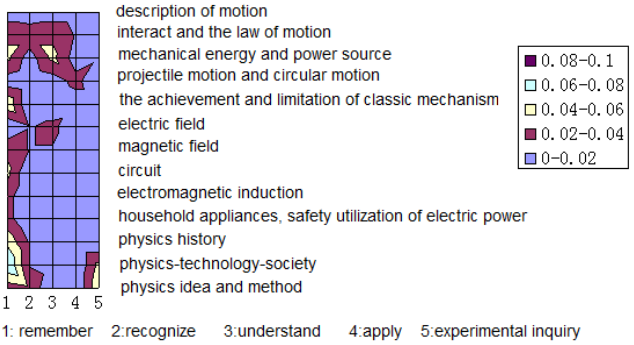

Figure 2. Curriculum standards emphasis

B. Analysis of exam papers

Our analysis group includes one physics education expert, one physics teaching researcher and three graduate students. One of the graduate students has 18 years teaching experience. We discussed and determined each test question's knowledge content and cognitive level according the same criterion and reached an agreement on its coding, Then we put all the codes into the table and transfer the number into ratio.

1. Guangdong physics exam

The Guangdong province physics exam paper included three question groups in which total 60 items, with a full mark of 100 and 90 minutes permitted time.

The Porter alignment index between curriculum standards and Guangdong physics exam is 0.38. As shown in table 5 and figure 3, the main content in Guangdong exam is description of motion (20.5%), interact and the law of motion (16.5%), and mechanical energy and power energy (15%). All of these topics come from the compulsive modules; however, the range of test content is smaller than that of curriculum standards.

Some of the new curriculum emphases such as physics history, physics-technology-society, physics idea and methods, experimental inquiry are not paid enough attention to and most of the cognitive skill tested in Guangdong physics exam is understand (43%). All of the above reasons make the Porter alignment index lower.

Table 1. Physics curriculum standard based on number of topics and cognitive skills

	Remember	Recognize	Understand	Apply	Experimental Inquiry	Total
Description of motion	1	0	1	1	1	4
Interact and the law of motion	4	4	4	2	1	15
Mechanical energy and power source	5	1	5	1	2	14
Projectile motion and circular motion	1	0	1	3	0	5
The achievement and limitation of classic mechanism	6	0	0	1	1	8
Electric field	0	2	3	0	0	5
Magnetic field	4	2	2	0	0	8
Circuit	5	0	0	0	0	5
Electromagnetic induction	3	0	0	0	0	3
Household appliances, safety utilization of electric power	3	0	0	2	0	5
Physics history	6	2	0	0	0	8
Physics-technology-society	9	2	1	0	5	17
Physics ideas and methods	3	4	0	0	6	13
Total	50	17	17	10	16	110

Table 2. Physics curriculum standard in ratios of topics and cognitive skills

	Remember	Recognize	Understand	Apply	Experimental Inquiry	Total
Description of motion	0.009	0	0.009	0.009	0.009	0.036
Interact and the law of motion	0.036	0.036	0.036	0.018	0.009	0.135
Mechanical energy and power source	0.045	0.009	0.045	0.009	0.018	0.126
Projectile motion and circular motion	0.009	0	0.009	0.027	0	0.045
The achievement and limitation of classic mechanism	0.054	0	0	0.009	0.009	0.072
Electric field	0	0.018	0.027	0	0	0.045
Magnetic field	0.036	0.018	0.018	0	0	0.072
Circuit	0.045	0	0	0	0	0.045
Electromagnetic induction	0.027	0	0	0	0	0.027
Household appliances, safety utilization of electric power	0.027	0	0	0.018	0	0.045
Physics history	0.054	0.018	0	0	0	0.072
Physics-technology-society	0.081	0.018	0.009	0	0.045	0.153
Physics ideas and methods	0.027	0.036	0	0	0.054	0.117
Total	0.45	0.153	0.153	0.09	0.144	1.00

Table 3. Composition of Guangdong province physics qualifying exam paper

Question group Order	Style	Score	Percentage
Group 1	30 multiple choice with single answer	30×1 =30	30%
Group 2	20 multiple choice with single answer	20×2=40	40%
Group 3	10 multiple choice with multiple answer	10×3=30	30%

Table 4. Guangdong physics exam based on points

	Remember	Recognize	Understand	Apply	Experimental Inquiry	Total
Description of motion	0	1.5	11	6	2	20.5
Interact and the law of motion	2	2.5	9	2	1	16.5
Mechanical energy and power source	3	0	9	2	1	15.0
Projectile motion and circular motion	0	3	4	2	0	9.0
The achievement and limitation of classic mechanism	1	1	2	0	0	4.0
Electric field	0	5	2	0	0	7.0
Magnetic field	1	1	0	7	0	9.0
Circuit	2	0	0	3	0	5.0
Electromagnetic induction	0	0	1	1	0	2.0
Household appliances, safety utilization of electric power	2.5	2	5	0	0	9.5
Physics history	2.5	0	0	0	0	2.5
Physics-technology-society	0	0	0	0	0	0
Physics ideas and methods	0	0	0	0	0	1.0
Total	14	16	43	23	4	100

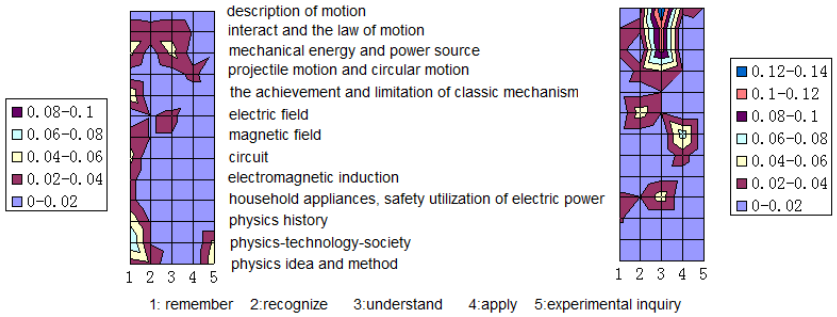

Figure 3: curriculum standards (left) and Guangdong exam (right) emphasis ratio

Table 5. Guangdong physics exam in ratios

	Remember	Recognize	Understand	Apply	Experimental Inquiry	Total
Description of motion	0	0.015	0.11	0.06	0.02	0.205
Interact and the law of motion	0.02	0.025	0.09	0.02	0.01	0.165
Mechanical energy and power source	0.03	0	0.09	0.02	0.01	0.150
Projectile motion and circular motion	0	0.03	0.04	0.02	0	0.090
The achievement and limitation of classic mechanism	0.01	0.01	0.02	0	0	0.040
Electric field	0	0.05	0.02	0	0	0.070
Magnetic field	0.01	0.01	0	0.07	0	0.090
Circuit	0.02	0	0	0.03	0	0.050
Electromagnetic induction	0	0	0.01	0.01	0	0.020
Household appliances, safety utilization of electric power	0.025	0.02	0.05	0	0	0.095
Physics history	0.025	0	0	0	0	0.025
Physics-technology-society	0	0	0	0	0	0.000
Physics ideas and methods	0	0	0	0	0	0.010
Total	0.14	0.16	0.43	0.23	0.04	1.00

Table 6. Composition of Ningxia province physics exam

	Question group Order	Style	Score	Percentage
Part 1	Group 1	16 multiple choice with single answer	16×2=32	32%
	Group 2	2 multiple choice with single answer	2×4=8	8%
Part 2	Group 3	12 fill-in-blank questions	12×1=12	12%
	Group 4	1 construction problem	1×8=8	8%
	Group 5	5 calculation question	5×6=30	30%
	Group 6	1 experimental problem	1×10=10	10%

2. Ningxia physics exam

The Guangdong province physics exam paper included three question groups in which total 60 items, with a full mark of 100 and 90 minutes permitted time.

Ningxia high school physics qualifying exam paper are comprised of two parts, with one part all multiple choice and mark 40, another part includes all question styles except multiple choice and mark 60. The permitted time is 100 minutes. What's more, there are additional questions with mark 20, since these additional questions are not a requirement for all students, they are not included in the coding.

The Porter alignment index between curriculum standards and Ningxia exam is 0.25. The main topics in Ningxia exam are description of motion (39%), interact and the law of motion (30%), projectile motion and circular motion (14%), all of which are the content in the compulsive modules and not any content from the selective modules. Less attention is paid to physics history, physics-technology-society, and ideas and methods. Since the calculation questions take a large percentage of the exam, it makes the content too concentrated and the cognitive skill level higher than curriculum standard. For example, the apply level of interact and the law of motion is 20%, explaining the alignment index between exam and curriculum standard is low.

Table 7. Ningxia physics exam in radios

	Remember	Recognize	Understand	Apply	Experimental Inquiry	Total
Description of motion	0.03	0.08	0.04	0.14	0.10	0.39
Interact and the law of motion	0	0.04	0.06	0.20	0	0.30
Mechanical energy and power source	0.01	0.02	0.04	0	0	0.07
Projectile motion and circular motion	0	0.02	0.06	0.06	0	0.14
The achievement and limitation of classic mechanism	0	0	0	0.08	0	0.08
Electric field	0	0	0	0	0	0.00
Magnetic field	0	0	0	0	0	0.00
Circuit	0	0	0	0	0	0.00
Electromagnetic induction	0	0	0	0	0	0.00
Household appliances, safety utilization of electric power	0	0	0	0	0	0.00
Physics history	0.02	0	0	0	0	0.02
Physics-technology-society	0	0	0	0	0	0.00
Physics ideas and methods	0	0	0	0	0	0.00
Total	0.06	0.16	0.20	0.48	0.10	1.00

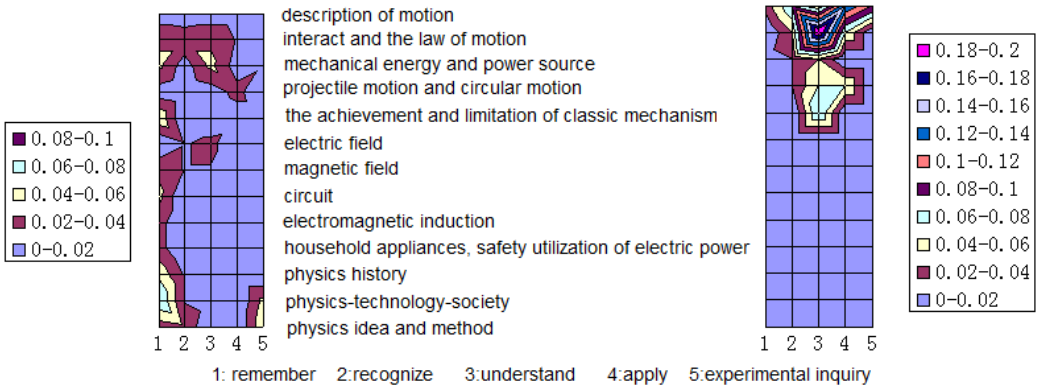

Figure 4. Curriculum standards (left) and Ningxia exam (right) emphasis ratio

Table 8. Composition of Shandong province physics exam

	Question group Order	Style	score	percentage
Part 1	Group 1	14 multiple choice with single answer	14×3 =42	42%
Part 2	Group 2	1 multiple choice with multiple answer and 1 fill-in-blank question	5 +8 =13	13%
	Group 3	2 calculation questions	9 +11 =20	20%
Part 2*	Group 4	1 multiple choice with single answer, 1 multiple choice with multiple answer , 1 fill-in-blank question, 1 experimental inquiry	5 +5 +6 +9 =25	25%

* The third part consists of two groups of questions for choice, with one for selective module 1-1 and the other for selective module 3-1. In order to compare with curriculum and other provinces, we only choose the items of elective module 1-1 here, which is designed for the art students.

Table 9. Shandong physics exam in radios

	Remember	Recognize	Understand	Apply	Experimental Inquiry	Total
Description of motion	0	0.075	0.06	0.04	0	0.175
Interact and the law of motion	0	0.015	0.03	0.08	0.05	0.175
Mechanical energy and power source	0	0	0	0.20	0	0.200
Projectile motion and circular motion	0	0	0.06	0.08	0	0.140
The achievement and limitation of classic mechanism	0	0	0.03	0.03	0	0.060
Electric field	0	0.06	0	0	0	0.060
Magnetic field	0	0	0	0	0	0.000
Circuit	0	0	0	0	0	0.000
Electromagnetic induction	0	0.04	0	0	0	0.040
Household appliances, safety utilization of electric power	0	0	0.05	0	0.04	0.090
Physics history	0.06	0	0	0	0	0.060
Physics-technology-society	0	0	0	0	0	0.000
Physics ideas and methods	0	0	0	0	0	0.000
Total	0.060	0.190	0.230	0.430	0.090	1.00

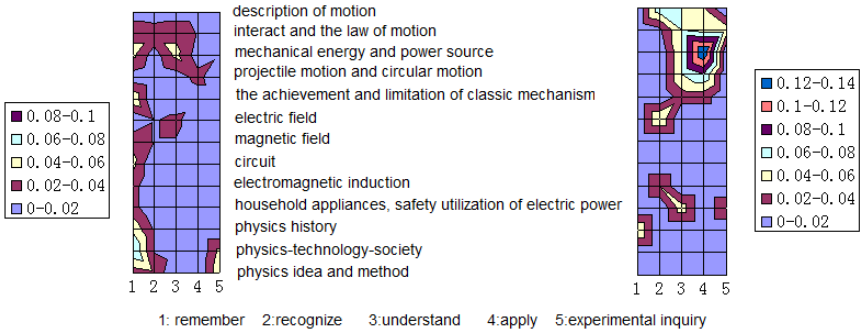

Figure 5. Curriculum standards (left) and Shandong exam (right) emphasis ratio

Table 10. Composition of Hainan physics exam

	Question group Order	Style	score	percentage
Part 1	Group 1	10 multiple choice with single answer	10×5 =50	50%
Part 2	Group 2	3 fill-in-blank questions	3×6 =18	18%
	Group 3	1 experiment data analysis problem	1×10 =10	10%
	Group 4	2 calculation question	2×8 =16	16%
	Group 5	Choose one question from three elective modules	1×6 =6	6%

Table 11. Shandong physics exam in radios

	Remember	Recognize	Understand	Apply	Experimental Inquiry	Total
Description of motion	0	0	0.11	0.05	0.10	0.260
Interact and the law of motion	0	0.05	0.02	0.22	0	0.290
Mechanical energy and power source	0	0	0.05	0.04	0	0.090
Projectile motion and circular motion	0	0	0	0.04	0	0.040
The achievement and limitation of classic mechanism	0	0	0.05	0	0	0.050
Electric field	0	0	0	0.05	0	0.050
Magnetic field	0.015	0	0.04	0.07	0	0.125
Circuit	0	0.0075	0	0	0	0.0075
Electromagnetic induction	0.015	0	0.015	0	0	0.030
Household appliances, safety utilization of electric power	0.0075	0	0	0	0	0.0075
Physics history	0.05	0	0	0	0	0.050
Physics-technology-society	0	0	0	0	0	0
Physics ideas and methods	0	0	0	0	0	0
Total	0.0875	0.0575	0.285	0.470	0.100	1.00

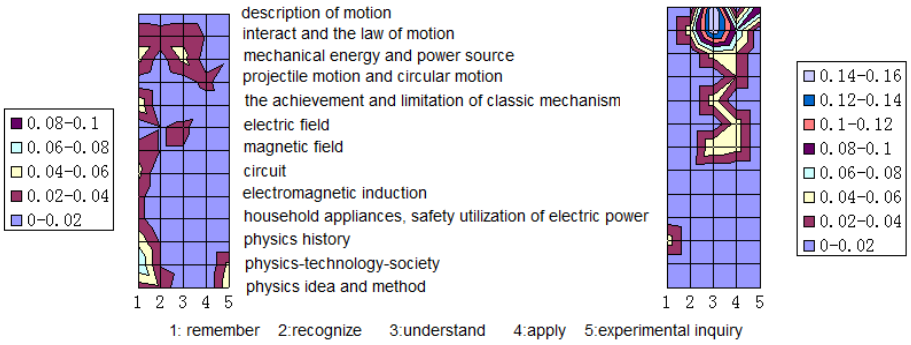

Figure 6. Curriculum standards (left) and Hainan exam (right) emphasis ratio

3. Shandong physics exam

Shandong physics exam consists of three parts. The first part and second part are compulsive questions, and the third part includes two groups of questions for selective modules, from which students must choose one. The total mark is 100, with 90 minutes permitted.

For Shandong province, the Porter alignment index between curriculum standards and Shandong test paper is 0.27. This exam focuses on compulsive modules 1 and 2, including the main contents about description of motion, interact and the law of motion, projectile motion and circular motion, but the content about electromagnetic is less, with low requirement.

Similar to Ningxia exam, there is less attention being paid to physics history, PTS, and physics ideas and methods. Due to the small amount of questions, some topics concentrate too much scores, for example, the application level of mechanical energy and power energy is 20%. The main cognitive skill level is application (43%), with higher requirement than curriculum standards.

4. Hainan physics exam

Hainan province physics exam paper is consisted of two parts. The first part is multiple-choice with 50 marks, and the second part is non-multiple-choice with 50 marks. The total permitted time is 1hour.

For Hainan province, the Porter alignment index between curriculum standards and its exam is 0.30. The amount of questions is small, and the test time is short. The contents of compulsive modules 1 are the main test point, focusing on the contents of description of motion (26%) and interact and the law of motion (29%). However, there is no content relating to physics-technology-society or physics ideas and methods at all. The test consists of multiple choice questions, fill-in-blank questions and calculation questions. Again, the cognitive skill focuses on application, with higher requirement when compared with curriculum standards. For example, the application in the topic of interact and the law of motion is 22%.

5. Comparison of physics exams in the four provinces

Figures 7 and 8 show the comparison of physics exam emphases among the 4 provinces.

As shown in figure 7, the cognitive levels tested by these four exam papers nearly present a normal distribution. The largest percentage of cognitive skill is understand, especially in Guangdong, Hainan and Ningxia provinces, and the largest percentage of cognitive skill for Shandong province is application. Other cognitive skill's ratio is very low, just around 10%.

From figure 8, we see that most of the four exam contents come from compulsive modules, and the content about descriptive of motion and interaction and the law of motion take half of the total marks.

While the content about physics-technology-society and physics ideas and methods are the emphasis of the curriculum, they are not included in all these four exam papers at all. What's more, there are some differences among these exam papers in their emphasis and coverage of the content. The Ningxia exam had a high emphasis on description of motion and interact and the law of motion, but Shandong exam had a high emphasis on energy. Guangdong and Hainan exam papers covered most of the topics, but Ningxia exam paper has the lowest content coverage, which only tests the contents of mechanics.

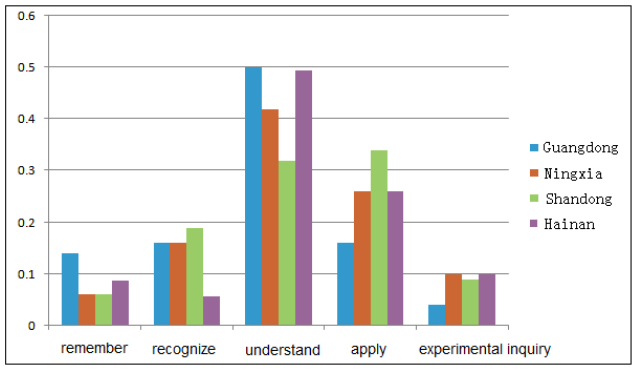

Figure 7. Comparison of cognitive level ratio among four provinces

IV. DISCUSSION

The results show that all of the Porter alignment indices between curriculum standards and these four provinces' exam paper is relatively low, with the value range from 0.25 to 0.38. The largest one is Guangdong's test, which is 0.38. There are two reasons for this. On one hand, curriculum standard is with wide range of content but low cognitive levels. On the other hand, the physics exam focuses on the content of mechanics and the cognitive skill of understanding and application. Obviously, the different emphasis of the exam and curriculum makes the Porter alignment index much lower than the P value in other researches.

There is a tradition of paying much attention to examination in China, which influences basic education greatly. In our opinion, just a piece of test paper can not reflect all of the requirements of curriculum standard owing to the limitation of test time and amount of test questions. It's reasonable that the test paper pays more attention to the cognitive skills of understanding and application, which will encourage students to deeply understand the basic physics conceptions and avoid just remembering knowledge or only using formula by itself. However, the range of test content will affect teaching, so the exam focusing on mechanics will have a negative effect on physics education especially for liberal art students.

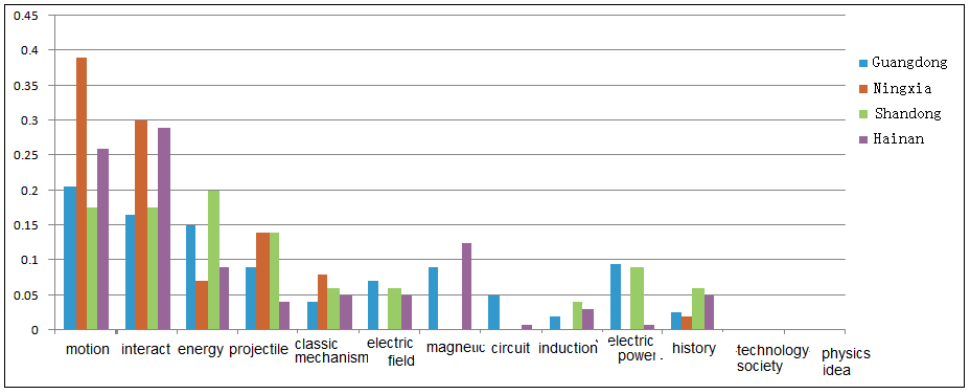

Figure 8. Comparison of knowledge content ratio among four provinces

Data shows that these four test papers have paid some attention to experimental inquiry and physics history, which reflected the new dimension of the physics curriculum. However, the limitation of assessing experimental inquiry ability by written test can not be ignored, since it can not represent students' real experimental inquiry ability, that's why real experimental test is also needed. The contents of PTS and physics ideas and methods which are also the new emphasis of the curriculum are absent in all these four test papers. How to assess these aspects is waiting for further study.

Emphasizing selectivity is one of the aims of the curriculum reform, but this is not obvious in these four test papers. Only Shandong and Hainan test papers provide some selective questions, other test papers have no flexible questions, and Ningxia test paper have not included selective module content at all.

From this study we see that the Porter alignment index method is very useful for describing and comparing the contents and cognitive levels of the curriculum and exam accurately, but the Porter alignment index value is just for reference. Except the analysis framework which affecting the P value greatly, there are many influence factors. For example, when we code the items, there is an assumption that the question context is new for students especially for those items testing apply skill. However, Chinese students have done a lot of questions to prepare for the examinations. If the contexts are familiar to students, the real cognitive level tested by this question will down, which will produce an error in the coding. In the meantime, the difference between these four provinces indicates that the alignment is related to the style and amount of questions. Guangdong test paper consists of 60 multiple-choice items, with larger content range and low cognitive level, all of which maybe the reason for the highest porter alignment index. However, we know that it is difficult to assess the high level cognitive skills if all the test questions are multiple-choice, what's more, it will bring bad effects to physics teaching especially in China which has a strong exam-oriented education background. This remains a topic of further research.

The result of the analysis of physics curriculum standard as shown in table 2 reveals that the traditional mechanics, which takes the largest proportion, is still the emphasis of content in the new curriculum. The cognitive level for most content is lower than apply which takes the lowest ratio (9%), but the higher cognitive levels are only reflected in the experimental inquiry which takes the ratio of 14.4%. So it is worth reflective thinking for policy makers that the physics content for all students need a balance in mechanics and other fields as well as for cognitive levels.

In order to make the test papers more align with the new curriculum, physics exam makers should pay more attention to the content coverage and the new requirements of the curriculum such as experimental inquiry, STS, physics ideas and methods, which also needs more research work on how to test these elements in exams.

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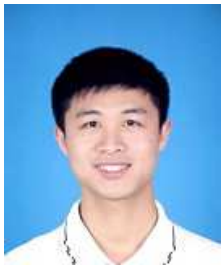

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