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The Main Problems of Internal Professional Structure of Mathematics Teachers in Middle Schools

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Investigating mathematics teachers in middle schools by questionnaire and interview, we find some problems of internal professional structure of mathematics teachers in middle schools. These are reflected in five aspects: professional theory, professional knowledge, professional ability, professional morality, reflection and innovative consciousness.

Keywords: mathematics education, questionnaire, interview, internal professional structure.
ZDM Classification: D13
MSC2000 Classification: 97C70

1. INTRODUCE

The new basic education curriculum reform has begun at the beginning of the 21st century. This new curriculum is an important reform on the traditional curricular system and notion (Ministry of Education 2001, 2003). Its major goals are: First, to improve students' qualities. Second, to cultivate their innovative spirits and abilities. Third, to develop their integrated practical abilities such as the ability of information collecting and conducting, the ability of acquiring new knowledge, and the ability of solving problem, the ability of interaction and cooperation. Fourth, to nourish their scientific and art qualities and the sense of environmental protection. Fifth, to form their perfect personalities. It changes the current situation that curriculum excessively emphasizes knowledge transfer. It promotes students to form active learning attitudes, to know how to learn and how to develop the correct value. It changes the current situation that

curricular structure excessively emphasizes subject, the number of courses are too much and lack integration. It sets up integrated courses in order to meet the need of students' development in different areas, and shows that curricular structure is balanced, synthesis and selected.

It changes the current situation that curricular content is too difficult, tedious, deviate and old, and excessively emphasizes written knowledge. It carefully selects the basic knowledge and basic skill for their all life's learning. It changes the current situation that curricular implement excessively emphasizes reception learning, stiff training. It encourages students to participate in learning initiatively, to explore, and to "learn by doing."

It changes the current situation that curricular evaluation excessively emphasizes choice. It advocates the function that promotes students' development, improves and betters teachers teaching practice. It changes the current situation that curriculum management emphasizes concentration too much. It carries out three level managements, including country, local government and school, and it fits curriculum to school and students.

All these challenge mathematics teachers' ideas and classing instruction greatly, and are urging them to change their teaching behavior and their understanding of teachers' role.

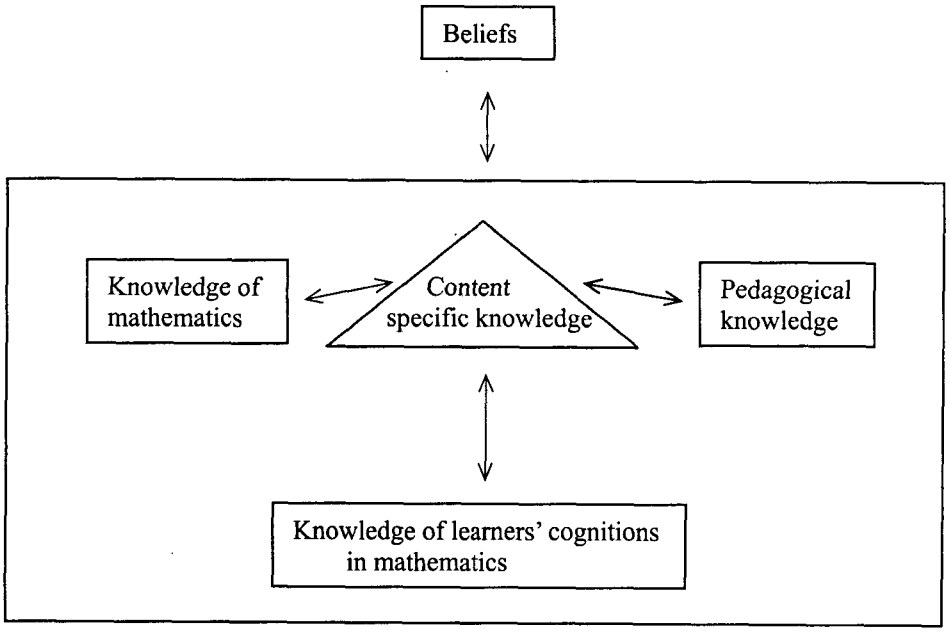
Currently, there are many insufficiencies in internal professional structure of mathematics teachers in middle schools (professional theory, professional knowledge, professional ability, professional morality, reflection and innovative consciousness). In order to obtain representational information and common conclusions, we have made an investigation on current situation.

2. THEORETICAL FOUNDATION

Shulman (1986; 1987a; 1987b) proposed a framework for analyzing teachers' knowledge that distinguished between different categories of knowledge: subject matter knowledge, pedagogical content knowledge, and curricular knowledge.

Peterson (1988) built on and modified Shulman's framework. She argued that in order to be effective, teachers of think in specific content areas, how to facilitate growth in students' thinking, and self-awareness of their own cognitive processes.

Fennema & Frank (1992) showed a model for research on teachers' knowledge:



Based on these theoretical foundations, we raise the internal professional structure of mathematics teachers in middle schools: professional theory, professional knowledge, professional ability, professional morality, reflection and innovative consciousness. Professional theory includes beliefs of mathematics such as mathematics concepts, propositions, problem-solving process, ideas, value and their interrelatedness and beliefs of the nature of mathematics teaching such as mathematics content knowledge should be closely related to students' real world and social development; teachers should show mathematics thinking and reveal the nature of mathematics in classroom teaching and so on.

Professional knowledge includes knowledge of background such as scientific and art knowledge, knowledge of mathematics and knowledge of condition such as pedagogical knowledge and knowledge of learning concerned with teaching practice, here three aspects of professional knowledge come together and they must be all considered as the whole, and we call it as personal practical knowledge. Professional ability includes ability of instructional design, ability of modern educational technique, ability of educational research, ability of interaction and cooperation.

Professional morality includes physical and mental qualities and personal characteristics. Reflection includes mathematics teachers' summarizing past teaching, introspecting present teaching and planning future teaching. Innovative consciousness includes mathematics teachers' solving unexpected situations, compiling instructional materials, discovering questions, analyzing questions, and solving questions, and so on.

3. METHOD

The method involves questionnaire and interview. First of all, we have investigated in a class of graduate students' who come from middle schools. According to this, we modified our questionnaire and then we have chosen 14 middle schools in Xiaogan city (Hubei province) and Wuhan city (Hubei province), including key middle schools and common middle schools of province, region, and cities. The subjects in this investigation are mathematics teachers in middle schools, and their basic conditions are as follows.

City		Xiaoga (%)	Wuhan (%)	Total (%)
Age	18–22	1.27	0.71	0.91
	23–28	43.04	18.44	27.27
	29–35	22.78	28.37	26.36
	36–40	16.46	29.79	25
	41–45	3.80	8.51	6.81
	46–50	7.60	7.09	7.27
	51–55	3.80	3.55	3.64
	56–60	1.27	3.55	2.73
Sex	Male	73.49	66.67	69.16
	Female	26.51	33.33	30.84
Years of teaching	1–4	40.26	11.56	21.43
	5–9	19.48	21.09	20.54
	10–15	18.18	25.85	23.21
	16–20	3.90	18.37	13.39
	21–25	10.40	8.84	9.38
	26–30	3.90	9.52	7.59
	31–35	3.90	2.72	3.13
	36–40	0	2.04	1.34
Academic credential	Below college-level	0	1.44	0.91
	College-level	28.40	17.99	21.82
	University-level	70.37	75.54	73.64
	Graduate-level	1.23	5.04	3.64

350 questionnaires were sent out and 251 were returned and valid. At the same time, we have interviewed some teachers in these schools so that we can understand their ideas about this questionnaire and their opinions about internal professional structure of mathematics teachers in middle schools. There are 58 closed-ended questions in this

questionnaire. Teachers make marks according to their degree of agreement about every question. (4, total agreement; 3, agreement; 2, somewhat agreement; 1, somewhat not agreement; 0, not agreement). The content consists of five aspects: professional theory, professional knowledge, professional ability, professional morality, reflection and innovative consciousness.

This questionnaire and the detailed data about the investigation and the proportional analysis of result are in the appendix 1 and 2. Meanwhile, in order to obtain more objective and scientific data, we have a χ^2-test on the data collected from two places (Xiaogan city and Wuhan city) which ratio of "total agreement" and "not agreement" is bigger than others. The result (Appendix 3) shows there is no significant difference in two parts.

According to the analysis, some main problems of internal professional structure of mathematics teachers in middle schools are as follows.

4. RESULT

4. 1 Professional theory

unit: %

Question / Degree	1	2	3	4	5	6	7	8	9
4	53.06	23.98	38.62	66.67	39.02	49.39	28.05	5.67	32.66
3	26.94	29.67	34.55	25.20	30.89	35.10	26.42	15.79	37.10
2	10.61	32.93	18.29	7.72	23.17	12.20	25.20	25.10	18.95
1	2.45	11.38	6.91	0.81	7.32	3.67	15.04	31.98	10.48
0	6.94	2.03	1.63	0.00	0.00	0.00	4.88	21.46	0.81

9.39% mathematics teachers think that mathematical foundations are changing and developing, and 39.02% mathematics teachers greatly agree that the art value of mathematics is high. 13.41% mathematics teachers somewhat agree the opinion that students' real world should be closely related to content knowledge. 19.92% mathematics teachers somewhat agree the opinion that mathematics itself can produce economic efficiency directly. 21.46% mathematics teachers regard the idea that students in the same classroom should have the similar scores. 11.29% mathematics teachers somewhat agree the idea that mathematics is lively and colorful.

These data show that some mathematics teachers don't understand the notion about mathematics and mathematics education. Thus, there are some phenomenons appearing in classroom teaching: mathematics is one of the subjects which have the least change;

some teachers only pay attention to theorems and laws in textbooks; they neglect the influences of social development on mathematics curriculum, they neglect the relationship between mathematics curriculum and students' real world. Colorful science and art value of mathematics aren't sufficiently embodied on the mathematics teaching. Some mathematics teachers haven't the notion that "different students should develop differently in mathematics." Thus, this type of mathematics teachers can't accomplish teaching tasks by ensuring both quality and quantity in the class. They just stiffly train students and let them do too much homework. All of these greatly add burdens on students.

unit: %

Question / Degree	14	15	16	17
4	41.20	22.58	19.76	19.20
3	37.20	41.94	42.74	40.00
2	16.00	28.23	26.21	26.00
1	4.40	5.65	8.87	10.40
0	0.80	1.61	2.82	4.40

41.20% mathematics teachers regard that the mutual actions between teachers and students should be noted. Actually, only 22.58% mathematics teachers give students sufficient time for independence learning. 19.76% mathematics teachers give students sufficient time for cooperative learning. 19.20 mathematics teachers give students sufficient time for exploration learning. Through individual interview, we get the message that the mutual actions in classroom teaching are heuristics. Now, the problem is that mathematics teachers have too heavy teaching tasks (in general, there are more than 60-70 students in the same classroom and there is too much exercises-book to correct. Mathematics teachers teach 12 classes or so in one week), and too great burdens (mostly because of intensively pressure for entering higher school) to let students study independently, cooperatively and explorative.

4. 2 Professional knowledge

unit: %

Question / Degree	20	21	22	23	26
4	4.42	23.79	26.21	31.17	13.01
3	16.87	34.27	37.10	38.06	51.22
2	26.51	25.81	21.37	20.24	27.24
1	33.73	14.11	14.06	9.72	6.50
0	18.47	2.02	1.61	0.81	1.63

In terms of knowledge of background, 21.29% mathematics teachers agree that they greatly profit from knowledge of foreign language. 58.06% mathematics teachers agree that better knowledge of modern education technique is necessary in the mathematics teaching.

63.31% mathematics teachers have rich knowledge of art. 69.23% mathematics teachers have rich knowledge of science. Successful mathematics education requires teachers who have comprehensive knowledge of background. In the interview, some mathematics teachers said, those who haven't comprehensive knowledge of background can't really do well in mathematics education.

Among three aspects of professional knowledge, mathematics teachers grasp knowledge of mathematics better than other aspects. But, there are still problems. Many teachers need to learn more knowledge if new content knowledge is added to the curriculum. The investigation data show that 64.2% mathematics teachers are familiar with 20th century knowledge of mathematical such as probability and statistics. The knowledge is added to new mathematics education curriculum reform and gives more help to students when they go into society in future. But some mathematics teachers feel somewhat strange about it. This reflects that an active teacher must learn continually and enrich himself in all his life. Thus, he can have a constantly development in profession.

As to knowledge of condition, the problem is that every mathematics teacher has learned pedagogical knowledge and knowledge of learning. However, different teachers have different comprehension on the instructive role in teaching practice. The result shows that novice teachers would be more puzzled than expert teachers. Why do some students' bad behaviors appear again and again, even they may develop a rebellious mentality? Why do students still make mistakes although teachers have corrected them in learning? Comparably, experienced teachers are good at applying pedagogical knowledge and knowledge of learning to teaching and using the knowledge to analyze students' cognition and psychology characteristic.

4. 3 Professional ability

unit: %

Question / Degree	32	33	34	35	36
4	6.40	17.27	15.26	21.37	39.60
3	20.80	32.53	27.71	35.48	36.80
2	29.20	30.92	34.94	27.02	19.20
1	24.80	14.86	16.47	12.50	2.80
0	18.80	4.42	5.62	3.63	1.60

In terms of modern education technique, mathematics teachers' level isn't satisfying. 27.2% mathematics teachers often use CAI. We know from interview that most teachers wish to use CAI, but some are incapable of it. Some are capable of it, but there is no condition. Some have conditions, but there is no time to make computer software. As we all know, modern education technique is a useful tool for learn and explore knowledge. They can develop students' innovative spirit and ability. So, if mathematics teachers lack this ability, educational resources would be wasted.

As to the relationship between teaching and research, 19.28% mathematics teachers think there is little relationship between research and mathematical teaching. 22.07% mathematics teachers seldom do experiments in mathematical teaching. 21.37% mathematics teachers think it is difficult to do education research in mathematical teaching. Meanwhile, 39.6% teachers think it will take too much time to do research in mathematical teaching. Through interviews, some teachers think this situation occurs because there are many tasks on teaching (as noted earlier in 4.1), and teachers have no time to do it. Actually, the idea that research takes up teaching time is fault. The fault lies on the fact that they don't consider close relationship between research and teaching. Currently, new basic education curriculum reform requires mathematics teachers have higher research competence. "Teacher is also researcher" is the main meaning of teacher professional development.

In interaction and cooperation, the data indicates that the communication between mathematics teachers and their colleagues, and students are more than the communication between mathematics teachers and parents. Mathematics teachers should enhance interaction and cooperation in all aspects, and then make teaching effect much better.

4. 4 Professional morality

unit: %

Question / Degree	41	42	43	44	45	46	47
4	58.40	56.00	47.79	58.06	45.78	50.80	64.40
3	31.20	37.60	45.38	37.50	43.78	35.60	31.20
2	8.40	4.40	6.43	5.24	9.24	10.80	2.80
1	1.20	1.60	0.80	0.00	1.61	2.40	1.20
0	0.80	0.40	0.00	0.00	0.00	0.40	0.40

From the data, it is an apparent fact that mathematics teachers' whole professional morality is satisfying. However, no matters the students are good or not, do mathematics teachers really treat them equally? Is there a value trend in making up classes for those who miss classes? Mathematics teachers' professional morality may greatly influence

students' whole life. Maybe a teacher's one word can change the development direction of students. So our teachers should pay attention to professional moral character.

4. 5 Reflection and innovative consciousness

In terms of reflection, most teachers often summarize past teaching, introspect present teaching. Comparably, plan future teaching is weak. We know some teachers have a fault idea that planning future teaching is leader's duty from interview. In fact, the consciousness of reflection plays an important role in mathematics teachers' professional development. If mathematics teachers have this awareness, they can introspect their teaching behavior, explore questions, summarize experience and form regularity recognitions and help them to develop their internal structure of profession.

unit: %

Question / Degree	51	52	53	54	55	56	57	58
4	8.87	34.15	32.13	52.24	15.73	49.60	17.27	25.81
3	31.45	52.85	45.78	38.37	50.81	41.94	38.15	42.74
2	36.29	11.38	18.88	7.35	21.37	6.85	30.52	22.98
1	16.53	2.03	2.81	1.63	6.85	2.02	11.24	5.65
0	6.85	0.00	0.40	0.41	5.24	0.00	2.81	2.82

In terms of innovative consciousness, 68.55% teachers regard close-book examination is a good way to evaluate teaching. These don't offer students more space to display themselves. At the same time, 40.32% teachers regard mathematics teaching as a process that is form concepts, propositions, and instances to exercises. 15.73% teachers raise questions that come from teaching materials except textbooks. 50.81% teachers raise questions that mostly come from teaching materials except textbooks. 55.42% teachers often compile teaching materials except textbooks. 2.81% never compile teaching materials. All these reflect mathematics teachers' awareness of innovation. If mathematics teachers lack the competence, how can they improve students' ability of innovation? Therefore, we should enhance the awareness of innovation further.

5. DISCUSSIONS

From the questionnaire and interview, we can see mathematics teachers in middle schools today have accepted advanced education ideas and theories. But, there are still some questions.

(1) Mathematics teachers' professional theory should be further developed. Professional theory involved in all aspects of education. If teachers didn't change their professional theory, their other aspects would be very difficult to change.

(2) Mathematics teachers should grasp not only mathematics knowledge, but also grasp scientific and art knowledge extensively. Teachers' knowledge is not a mode of "mathematics+ pedagogical." It should be a highly organized and dynamic combination of different knowledge.

(3) Mathematics teachers should strengthen the ability of modern education technique and develop the ability of research as well. If Mathematics teachers' research ability were improved, their professional level would be improved, too.

(4) Mathematics teachers should strengthen their reflection and innovation consciousness. The sense of reflection and innovation would make the teachers growth rapid and continuous. How to cultivate innovative mathematics teachers is an important research theme.

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APPENDIX 1

Questionnaires about the internal professional structure of mathematics teachers in middle schools

school __ sex__ age__ years of teaching __ academic credential__

Dear Teachers:

Mathematics education is promoted by social and self-development. It challenges mathematics teachers greatly. We try to investigate the internal profession structure of mathematics teachers in middle schools, including professional theory, professional knowledge, professional ability, professional morality, reflection and innovative consciousness. Please fill in this questionnaire carefully. Thank your sincerely time and consideration!

(According to the degree of agreement about every question on the left, please tick "√" on the corresponding right location.)

questions	the degree of agreement (high→low)				
	4	3	2	1	0
1. Mathematics foundations are unchanging.					
2. Content knowledge should be closely related to students' real world.					
3. Content knowledge should be closely related to social development.					
4. The art value of mathematics is high.					
5. The scientific value of mathematics is high.					
6. Mathematics is a tool which is used in other courses.					
7. Mathematics itself can product economic efficiency directly.					
8. Students in the same classroom should have the similar scores.					
9. Mathematics is lovely and colorful.					
10. Mathematics is a combination of concepts, propositions, questions, language, methods and ideas.					
11. How to do exercises in textbooks is the ultimate aim of learning mathematics.					

questions	the degree of agreement (high→low)				
	4	3	2	1	0
12. Problem solving is more important than purely doing exercises in textbooks.					
13. You cultivate students emotion to encourage them to love mathematics.					
14. There are many mutual actions between teachers and students in classroom.					
15. You give students sufficient time for independence learning.					
16. You give students sufficient time for cooperation learning.					
17. You give students sufficient time for exploration learning.					
18. You pay attention to mathematics ideas and methods.					
19. You pay attention to the knowledge of development during your teaching.					
20. Foreign language level benefits mathematics teaching.					
21. Modern education technique is necessary in the mathematics teaching.					
22. You have rich knowledge of art.					
23. You have rich knowledge of science.					
24. You have better ability of problem solving.					
25. You are familiar with the mathematics instructional materials.					
26. You are familiar with 20th century mathematical knowledge.					
27. You apply pedagogical knowledge to mathematics teaching consciously.					
28. You apply knowledge of learning to mathematics teaching consciously.					
29. You have the ability to design mathematics instructional procedure.					
30. You have the ability to design mathematics instructional methods.					
31. You have the ability to design mathematics instructional correlated scene.					

questions	the degree of agreement (high→low)				
	4	3	2	1	0
32. You often use CAI.					
33. There are close relationship between research and mathematical teaching.					
34. You do experiments in mathematical teaching.					
35. It is difficult to do mathematics research in mathematical teaching.					
36. It takes too much time to do research in mathematical teaching.					
37. You can communicate with your colleagues frequently.					
38. You can communicate with your students					
39. You can communicate with your students' parents frequently.					
40. You can communicate with the dean of class frequently.					
41. You love mathematics teaching, and have strong sense of responsibility.					
42. You are active and you can give students stimulation frequently.					
43. You are open-minded and have extensively hobbies.					
44. You can listen to students' viewpoints.					
45. Students like to communicate with you.					
46. You treat those students sincerely who have low scores.					
47. The relationship between your colleagues and you is good.					
48. You can summarize past teaching.					
49. You can introspect current teaching.					
50. You can plan future teaching.					
51. Mathematics teaching is a process that is from concepts, propositions, and instances to exercises.					
52. You have the ability to conduct unexpected situations.					
53. You can abstract mathematics problems from practical problems.					

questions	the degree of agreement (high→low)				
	4	3	2	1	0
54. You can help students to think and solve problems in different ways.					
55. Your questions come from instructional materials.					
56. You can encourage students to raise views by themselves.					
57. You often compile instructional materials.					
58. Closed-book examination is a good way to evaluate teaching.					

APPENDIX 2

The detailed data about the investigation and the proportional analysis of result

unit: %

Question / Degree	1	2	3	4	5	6	7	8	9
4	53.06	23.98	38.62	66.67	39.02	49.39	28.05	5.67	32.66
3	26.94	29.67	34.55	25.20	30.89	35.10	26.42	15.79	37.10
2	10.61	32.93	18.29	7.72	23.17	12.20	25.20	25.10	18.95
1	2.45	11.38	6.91	0.81	7.32	3.67	15.04	31.98	10.48
0	6.94	2.03	1.63	0.00	0.00	0.00	4.88	21.46	0.81

unit: %

Question / Degree	10	11	12	13	14	15	16	17	18
4	54.69	5.60	57.66	56.50	41.20	22.58	19.76	19.20	66.67
3	28.98	18.00	33.47	30.08	37.20	41.94	42.74	40.00	25.61
2	12.65	22.80	7.26	10.57	16.00	28.23	26.21	26.00	6.50
1	2.45	24.40	8.47	2.03	4.40	5.65	8.87	10.40	0.81
0	1.22	29.20	0.40	0.81	0.80	1.61	2.82	4.40	0.41

unit: %

Question / Degree	19	20	21	22	23	24	25	26
4	50.00	4.42	23.79	26.21	31.17	34.54	48.19	13.01
3	32.00	16.87	34.27	37.10	38.06	57.83	40.96	51.22
2	11.60	26.51	25.81	21.37	20.24	5.62	8.84	27.24
1	6.00	33.73	14.11	14.06	9.72	1.61	1.61	6.50
0	0.80	18.47	2.02	1.61	0.81	0.40	0.40	1.63

unit: %

Question / Degree	27	28	29	30	31	32	33	34
4	24.50	26.21	35.89	37.90	18.55	6.40	17.27	15.26
3	51.41	50.40	50.00	51.21	62.50	20.80	32.53	27.71
2	18.47	18.95	12.50	9.27	15.73	29.20	30.92	34.94
1	4.82	4.03	2.02	2.02	2.82	24.80	14.86	16.47
0	0.80	0.40	0.00	0.00	0.40	18.80	4.42	5.62

unit: %

Question / Degree	35	36	37	38	39	40	41	42
4	21.37	39.60	43.55	44.18	25.81	43.33	58.40	56.00
3	35.48	36.80	41.13	42.57	35.48	37.92	31.20	37.60
2	27.02	19.20	13.71	11.65	20.56	14.17	8.40	4.40
1	12.50	2.80	0.81	0.80	12.10	3.33	1.20	1.60
0	3.63	1.60	0.81	0.80	6.05	1.25	0.80	0.40

unit: %

Question / Degree	43	44	45	46	47	48	49	50
4	47.79	58.06	45.78	50.80	64.40	50.20	51.20	30.52
3	45.38	37.50	43.78	35.60	31.20	41.37	38.40	46.59
2	6.43	5.24	9.24	10.80	2.80	6.83	8.80	17.67
1	0.80	0.00	1.61	2.40	1.20	1.20	1.20	4.42
0	0.00	0.00	0.00	0.40	0.40	0.40	0.40	0.80

unit: %

Question / Degree	51	52	53	54	55	56	57	58
4	8.87	34.15	32.13	52.24	15.73	49.60	17.27	25.81
3	31.45	52.85	45.78	38.37	50.81	41.94	38.15	42.74
2	36.29	11.38	18.88	7.35	21.37	6.85	30.52	22.98
1	16.53	2.03	2.81	1.63	6.85	2.02	11.24	5.65
0	6.85	0.00	0.40	0.41	5.24	0.00	2.81	2.82

APPENDIX 3

Question 1	$\chi^2 = 3.764$;	Question 2	$\chi^2 = 4.07$;	Question 7	$\chi^2 = 4.1485$;
Question 8	$\chi^2 = 6.3565$;	Question 9	$\chi^2 = 6.285$;	Question 11	$\chi^2 = 2.4528$;
Question 20	$\chi^2 = 1.592$;	Question 21	$\chi^2 = 4.545$;	Question 22	$\chi^2 = 1.4003$;
Question 32	$\chi^2 = 5.844$;	Question 33	$\chi^2 = 4.256$;	Question 34	$\chi^2 = 5.5566$;
Question 35	$\chi^2 = 5.7337$;	Question 39	$\chi^2 = 5.0225$;	Question 51	$\chi^2 = 1.823$;
Question 55	$\chi^2 = 5.125$;	Question 57	$\chi^2 = 3.448$.		

$$df = (r-1)(c-1) = (2-1)(5-1) = 4,$$

according to χ^2 table, we find $\chi^2_{(4)0.05} = 9.49$, because all of $\chi^2 \leq 9.49$, $P > 0.05$. So, the result shows there is no significant difference in two parts.