ТЕОРИЯ И МЕТОДИКА ПРОФЕССИОНАЛЬНОГО ОБРАЗОВАНИЯ

УДК 37.0

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База и данные международного лонгитюдного исследования математической подготовленности учителей

В настоящей статье представлены результаты международного исследования уровня математической и профессиональной подготовленности будущих учителей математики. Сравнительный анализ результатов международного мониторинга свидетельствует о том, что пока еще уровень профессиональной подготовленности учителей математики средней школы в России к педагогической деятельности превышает не только средний уровень по странам – участницам проекта, но и занимает лидирующие позиции.

Ключевые слова: математическая и профессиональная подготовка, учитель математики, международное тестирование.

E. I. Smirnov

Base and Data of the International Longitude Research of Teachers' Mathematical Readiness

In the present article results of the international research of level of mathematical and professional readiness of future Mathematics teachers are presented. The comparative analysis of results of the international monitoring testifies that for the present level of professional readiness of Mathematics teachers of high school in Russia to the pedagogical activity exceeds not only the average level among the countries – participants of the project, but also takes leading positions.

Key words: mathematical and professional training, a Mathematics teacher, international monitoring.

Russia is a large country and our aims were to have a sample of new qualified teachers (trainees) taken from different regions and Pedagogical Universities with different educational programs. There are Yaroslavl State Pedagogical University (near Moscow) – YSPU, Vologda State Pedagogical University (north of Russia) – VSPU and Perm State Pedagogical University (Ural Mountains) – PSPU. We had 174 future teachers (Primary – 63 girls; Secondary – 101 girls + 10 boys): Secondary(S) + Primary (P): YSPU – (S49+P20); VSPU – (S30+P11); PSPU – (S32+P32). It is typical for Russia to have only women as teachers in Primary schools and kinder gardens. So for YSPU we have the following structure of education: (S) – Linear Teacher Training (fife years), (P) – Bachelor of Education (four years)+ one year of vocation; for VSPU: (S) – Linear Teacher Training (fife years), (P) – Linear Primary Teacher Training (four years); for PSPU: (S) – Bachelor of Education (four years)+ one year of vocation, (P) – Bachelor of Education (four years)+ one year of vocation. Some of Primary new qualified teachers graduated the Pedagogical College and continued vocational education in high school. It is Russian tradition but more than 60 % of trainees were born in villages and small towns. Another tendantion is the growing of men as future teachers of Secondary in sample going low to urbanization of towns (Perm-1, Yaroslavl-3 and Vologda-6).

The following *Table 1* shows the percentage of trainees (NQT) who actually go into teaching directly after training and also information about where and what type of schools or job in education area they choose.

Table 1

	Yaroslavl			**Vologda**			**Perm**		
	Number of NQT	Teachers area	Details	Number of NQT	Teachers area	Details	Number of NQT	Teachers area	Details
Secondary ∑ 111 **56,7 %**	49	28 **57,1 %**	3(PG) 5(ME) 20(TD)	32	17 **53,1 %**	- 9(ME) 8(TD)	30	18 **60 %**	3(PG) 5(ME) 10(TD)
Primary ∑ 63 **82,5 %**	20	18 **90 %**	1(PG) 1(ME) 16 (TD)	32	23 **71,8 %**	– 6(ME) 17(TD)	11	11 **100 %**	– 4(ME) 7(TD)

Notes: **PG** – Post Graduate Students; **ME** – Manager of Education; **TD** – Teaching directly.

The best results of Primary trainees (82,5 % in education area) have been explained by these professional activity as part time's good practice in kinder gardens or primary schools during training period at University. Also we remark that a half of Primary graduates came to University after Pedagogical College. However Secondary trainees have more high level of scientific thinking (5 % continue of education) and managing skills (30 % from "Teachers area" opposite to 17 % for primary graduates). If we look on percentage of trainees who teaching directly (TD) so 33 % of secondary trainees opposite to 63,5 % of primary one. It is tradition in Russia educational system to appoint the school mentors for every trainees TD, which help to defining the area of NQT's methodical activity and diagnostic of initial teaching experience: skills, evaluation, problems and so on. Moreover some of TD teachers became qualified teachers (nominated on first or second category) during their first year of teaching.

This is illustrated below for both Primary and Secondary samples in the following three bar charts.

PRIMARY: Part A: 40 marks on relatively straight forward questions

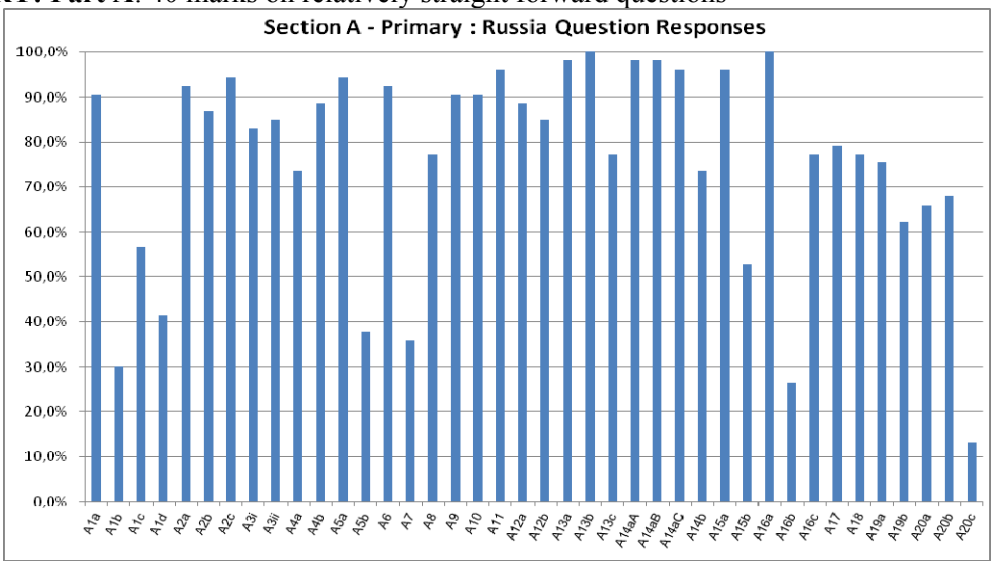


Fig. 1

It is very important for Russia (fig. 1) to explain low results of responses on questions (*problem's questions*): A1b, A1d, A5b, A7, A16b and A20c (data are **low 40 %**). Analysis of real situation with Primary student's skills (tutor's interview, exams, applications and correlation) has defined the problem points: real numbers should be learned more deeply *with different kind of representations* (R. Dedekind, G. Kantor, K. Weierstrass) *and using the practical skills*; our students have very small ability to *solve problems in nonstandard situation* (reflection relatively invisible point, limiting theorems of probability and so on).

PRIMARY: Part B: 20 marks on relatively straight forward questions

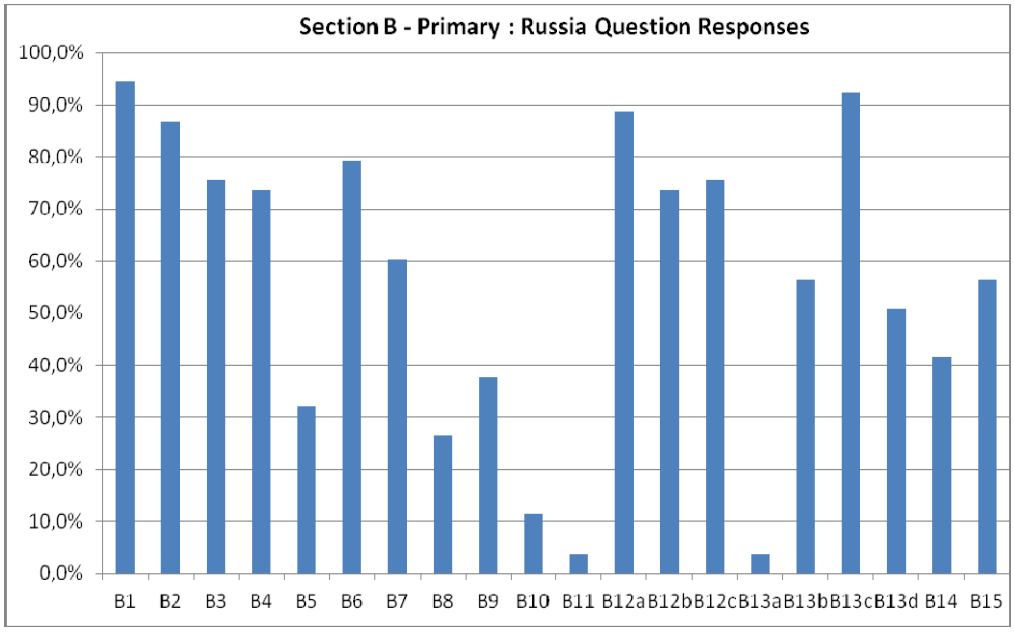


Fig. 2

Problem's questions in fig. 2: B5, B8, B9, B10, B11 and B13a (data are low 40 %). It is interesting to remark that we have the repeating and expansion of area's difficulties: *modeling of real process, operation with integers, nonstandard situations*. With another hands the volume of *unstable zone* **40 %-75 %** of question responses for Primary: Part A (understanding) – 15 %; Part B (calculating and algorithms) – 45 %. It means that the quality of mathematical skills and competence of future teacher will be upper if *special attention paid to algorithms and calculating procedures* in teaching mathematics.

Responses (fig. 3) of Primary (Part B) and Secondary (Part A) on common questions may be classified as basic part of mathematical culture of teacher: we see that *unstable zone* 40 %-75 % for Secondary is 20 %, which opposite to 45 % for Primary. Moreover there are no *problem's questions* (**low 40 %**) for Secondary: it seems that data are under the strong influence of *fundamental knowledge and best scientific thinking* of trainees for Secondary. So we should look on 4 question responses from unstable zone for Secondary: A6, A9, A11 and A14. Some difficulties concern with such questions we relate on *insufficiency of creativity and modeling skills* of trainees.

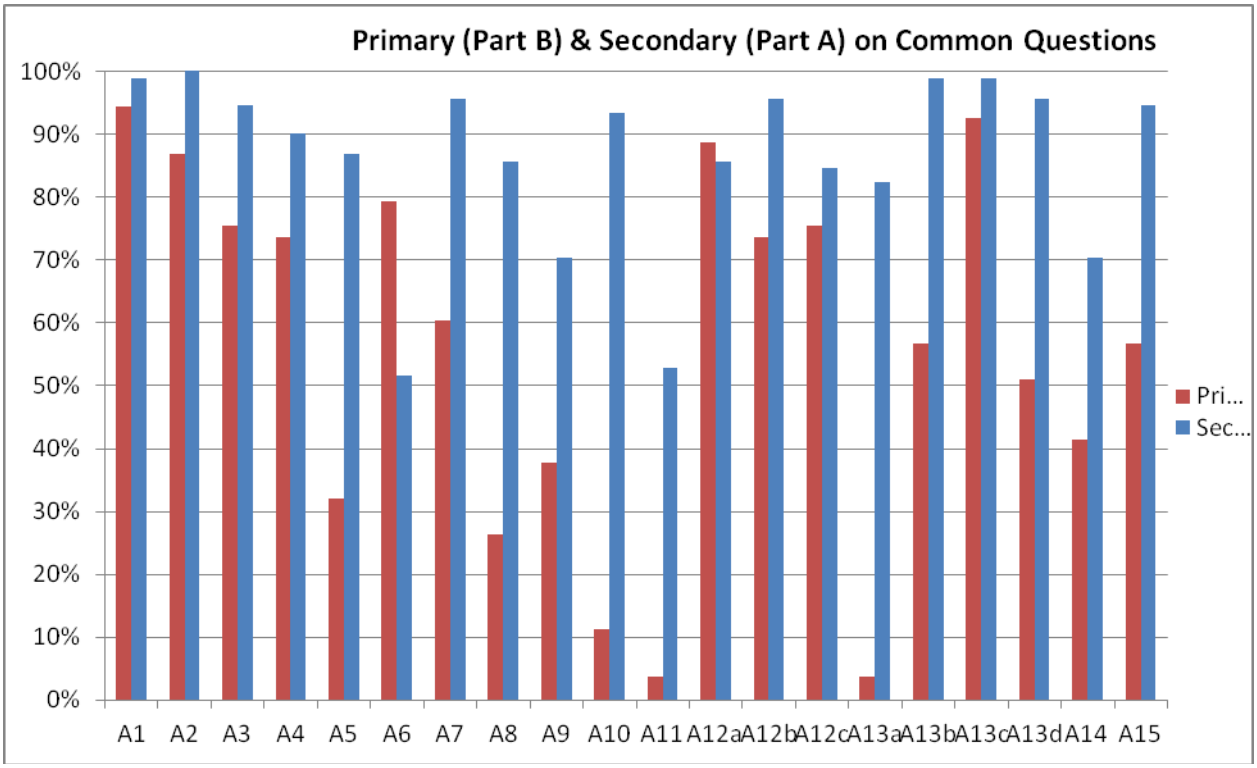


Fig. 3

SECONDARY: Part B: 20 marks on more advanced mathematical topics

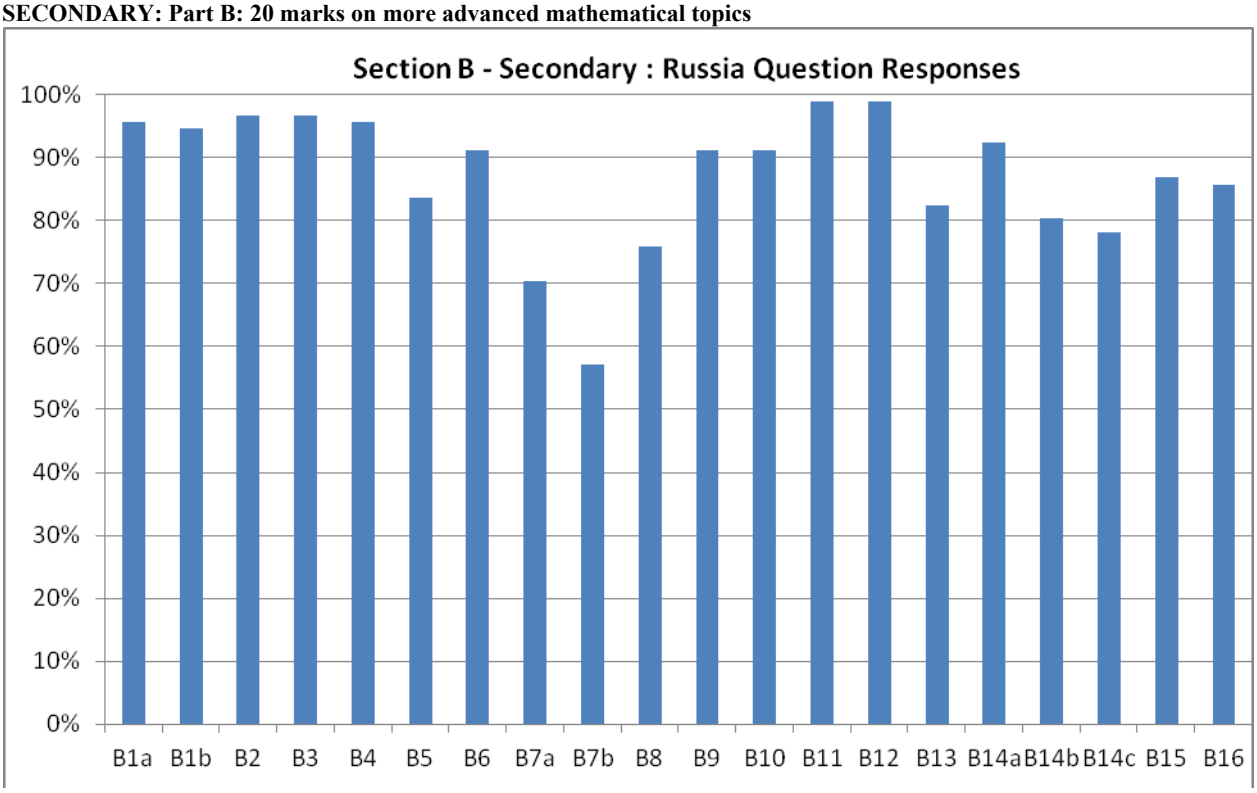


Fig. 4

Question responses of students (fig. 4) for Secondary (Part B), most characterized vocational habits, have shown high level of mathematical training and professional skills. However question responses B7a, B7b and B8 are drawn up in unstable zone. We think this situation show some problems of *links actualization between school and high mathematics* in teaching process. The concept of "limit" is not stud-

ied in secondary school (infinite geometric series is limiting process), but pupils know the concept of "geometric progression" and sometimes – the formula of "sum of this series". This moment will become half forgotten if during of studying the concept "limit of function" in high school we did not fixed links with concepts of " geometric and arithmetic progression" on high level and details of generalization. Another reason of problem is being the "invisible subjects" as "…" in signs of geometric and arithmetic progression:

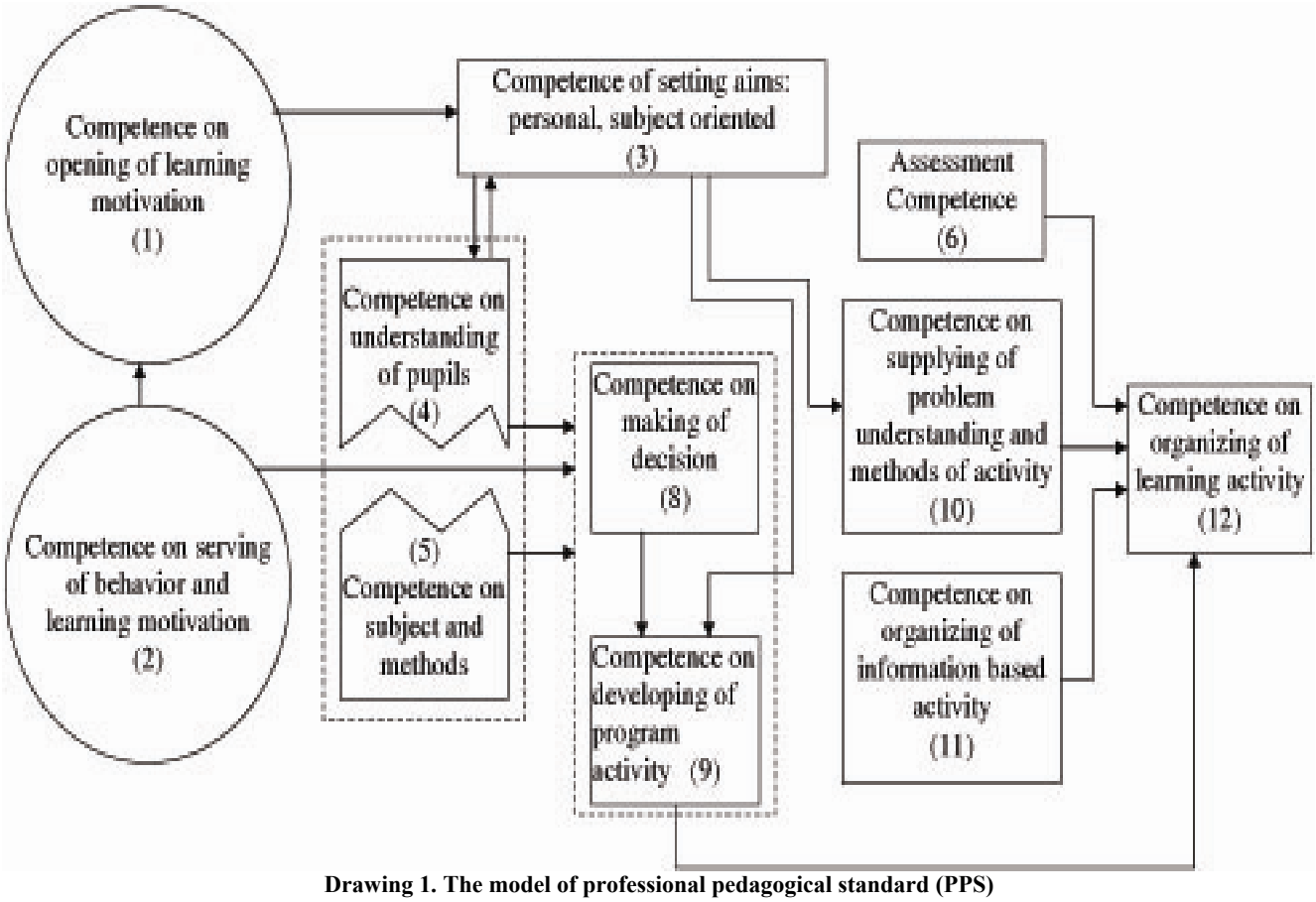
$$5 + 2{,}5 + \ldots + \ldots \text{ or } 2 + \ldots + 44.$$

It require the *development of theoretical thinking* of students and efforts in this direction should be defined and concreted.

Диагностика аффективной сферы личности педагога

It was very interesting to compare trainee's responses on questionnaire with contents of *Professional standard of pedagogical activity of teacher*, which was created in Russia on 2007 under supervising of very famous psychologist V. Shadrikov.

First block of questions: "1a, 1b, 1c, 1d" with data 73,8 % , "4" with data 78,1 %, "7" with data 72,2 % characterize the level of motivation and success on mathematics, which should supply of forming (5) from drawing 1 [1]. The responses on "question of 6" are very important for teacher competence: mathematics should be studied as integrative course. Student's responses data is 46,2 %. It is show that special activity in teaching mathematics really must be created using some integrative courses and constructs, research activity in vocation area following to student's interests and experience.



Drawing 1. The model of professional pedagogical standard (PPS)

Second block – a question "9" is asked both primary and secondary participants what they felt were the most important attributes for a teacher of mathematics. This is the summary of their responses (the numbers were used in the ranking of the attributes):

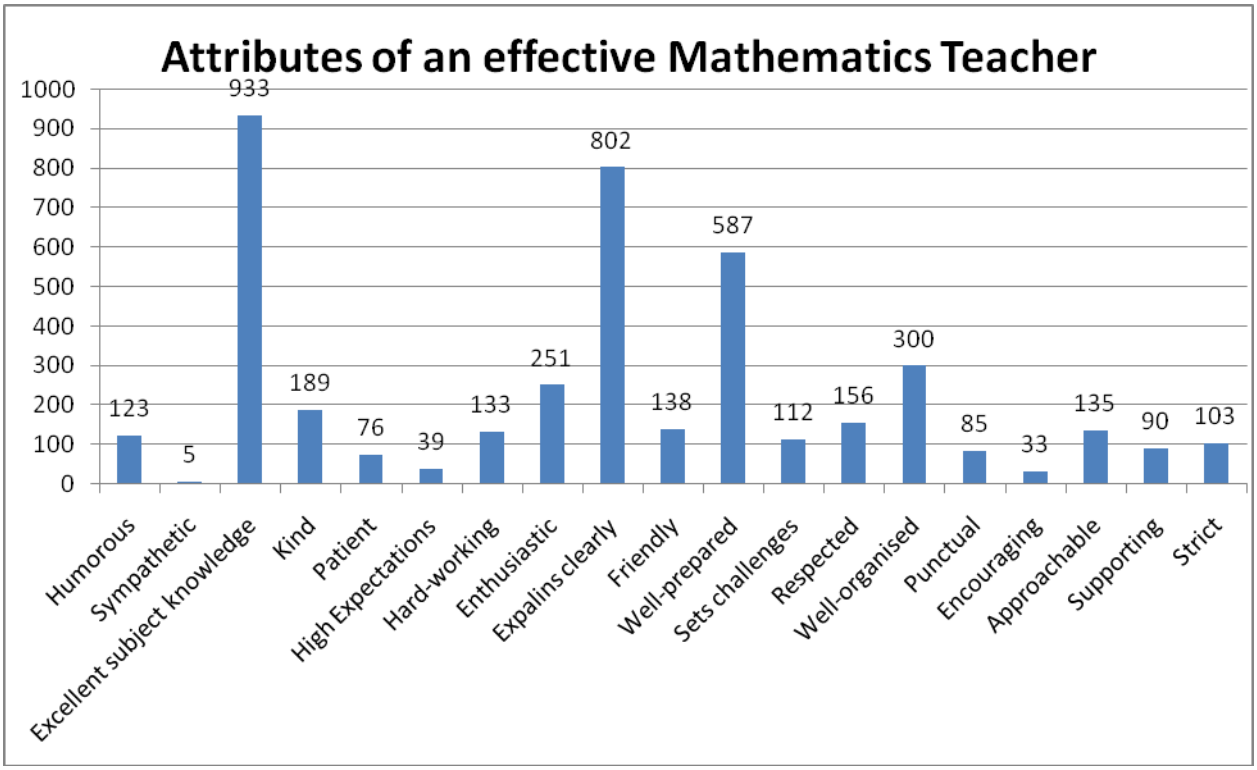


Fig. 5

It is very interesting that three positions are leading in England and Russia data: (1) "Excellent subject knowledge", (2) "Explains clearly" and (3) "Well-prepared". There was only one significant difference in the responses: Russia is sequence: 1, 2, 3, England: 2, 3, 1. These data is typical for Russia and reflect dreams about basic role of *competence on subject and methods* ((5), drawing 1).

Another "question 11" with interesting results was "Topics which Trainees did not feel confident about".

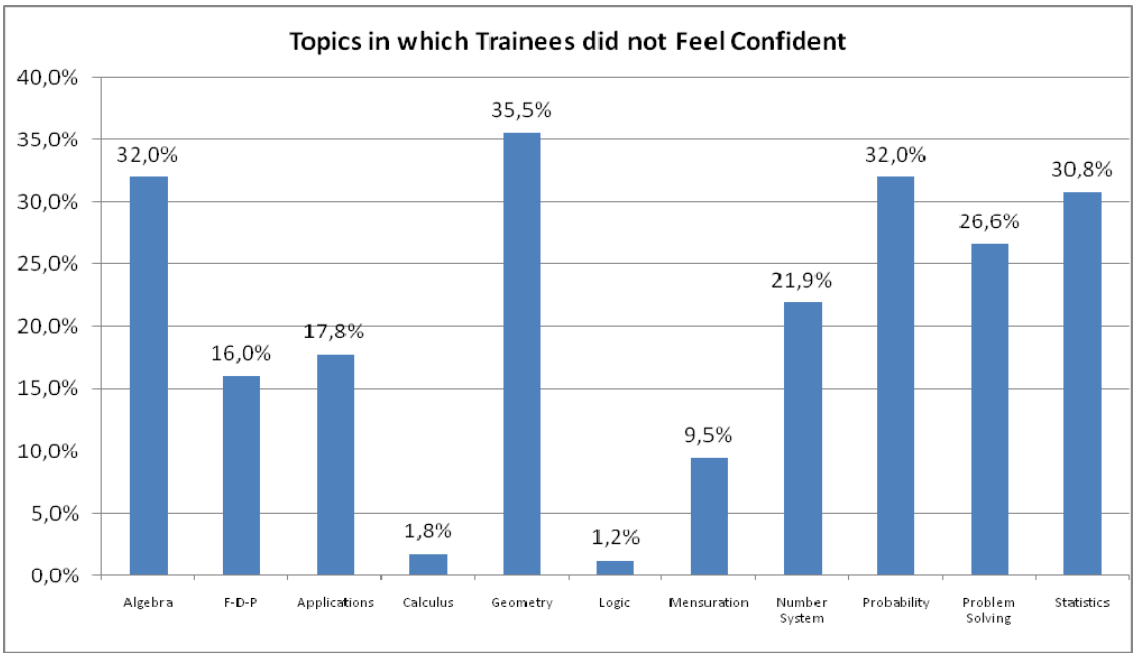


Fig. 6

First conclusion: it was very unexpectedly to know that most difficult topics in high mathematics as "Calculus" and "Logics" are became in confident zone (lower 5 %) for Russian trainees. We guess that it is concern with good selection of future teachers at the beginning of Millennium and high level of teaching tradition in Russia. It is true this moment we have strange situation than future teachers can to enter in University without suitable motivation, mathematical abilities and special thinking.

Second conclusion: trainees did not feel confident in "Probability" – 32,0 % and "Statistics" – 30,8 % because stochastic line in school mathematics was involved only some years ago and learning of stochastic require from pupils a good potential skills in modeling of real process what always was a problem for Russia.

Third conclusion: big problem with "Geometry" – 35,5 %, so starting from R. Descartes, concern with developing of pupil's thinking and hypothetical opportunities to apply geometrical knowledge. However an integration of geometrical, analytical, algebraic, stochastic and information knowledge in teaching mathematics using different resources will be a good practice to make topics more confident for students.

It was very important to compare positions defined in "Question 12" and it's realization for other countries with *PPS* in Russia. Indeed *PPS* is proved using and generating the good practice of teachers, valid and psychological laws of pupil's development. So it can define the main positions which will be addressed to trainees by their training courses. If we will look on next histogram so remark that most positions are coincided.

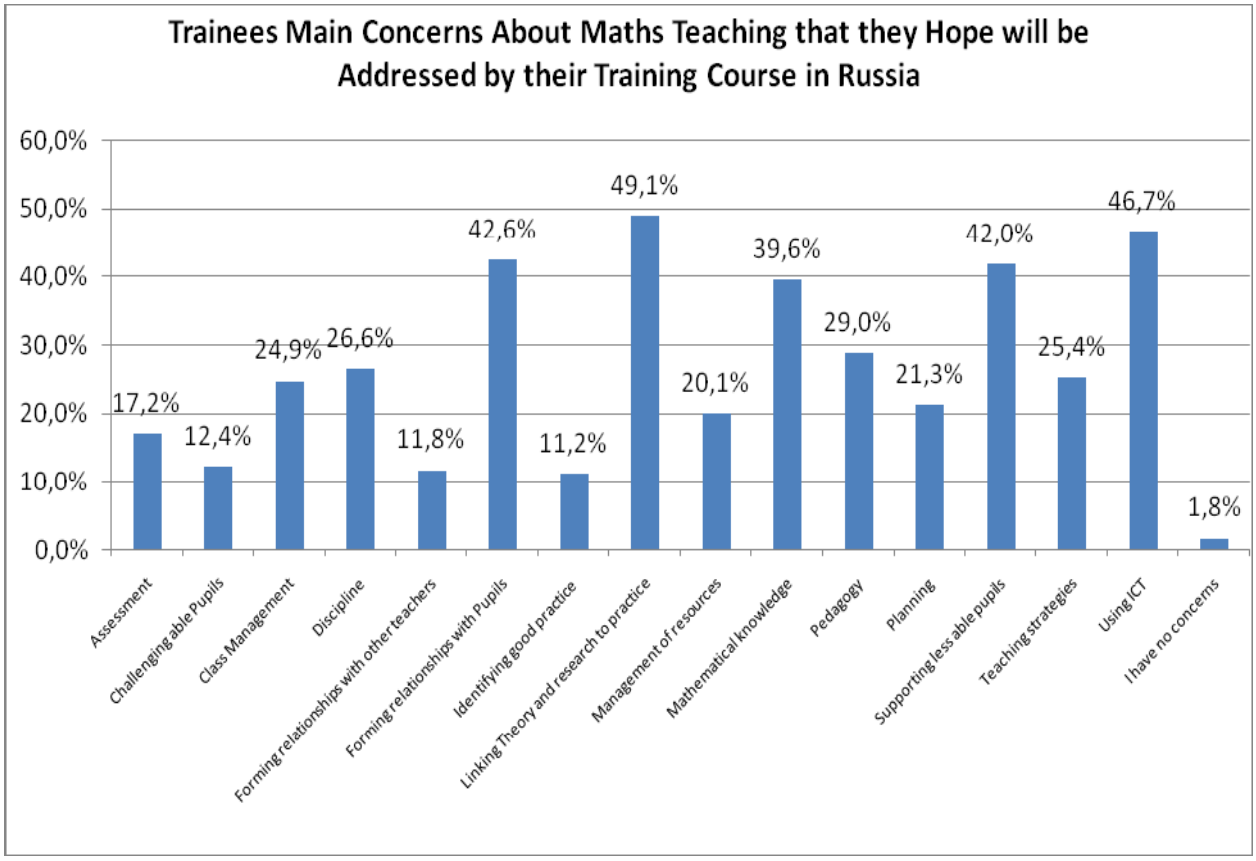


Fig. 7

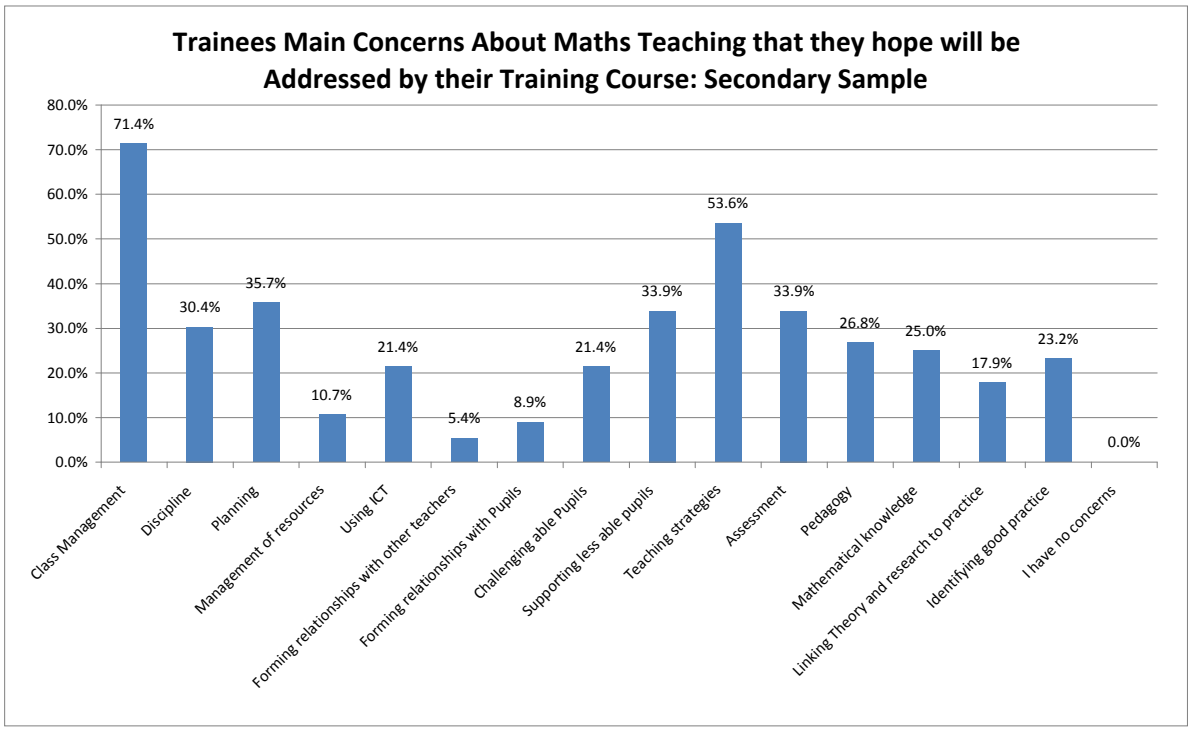


Fig. 8

However we see some difference (more than 5 %) in positions looking on England and Russia data: more than 10 positions. Some of them (less 20 %) – 6 positions ("Discipline", "Planning", "Management of resources", "Using ICT", "Teaching strategies", "Pedagogy" concern with directness to: *1) pupils; 2) contents and process; 3) teacher.* It is very interesting that 4 positions (more than 20 % till 60 %) – "Class Management", "Forming relationship with other teachers", "Challenging able pupils", "Identifying good practice" are based only on *1) and 3)* i.e. on personal factors and define basic positions of difference in educational systems. Moreover those *three positions* from them show the most volume of Russian parameters.

Trainee's responses to the question "What is the length of time that you expect to remain in teaching" have shown a big problem with prestige of teacher profession: it is small salary, old school equipment and resources and so on.

Fig. 9

A career aspiration of Russian trainees seems adequate to real situation in secondary schools. It is very difficult to built plans and prognoses if most influence on career growing of trainees will be defined by staff relations at school, but not special abilities of NQT's.

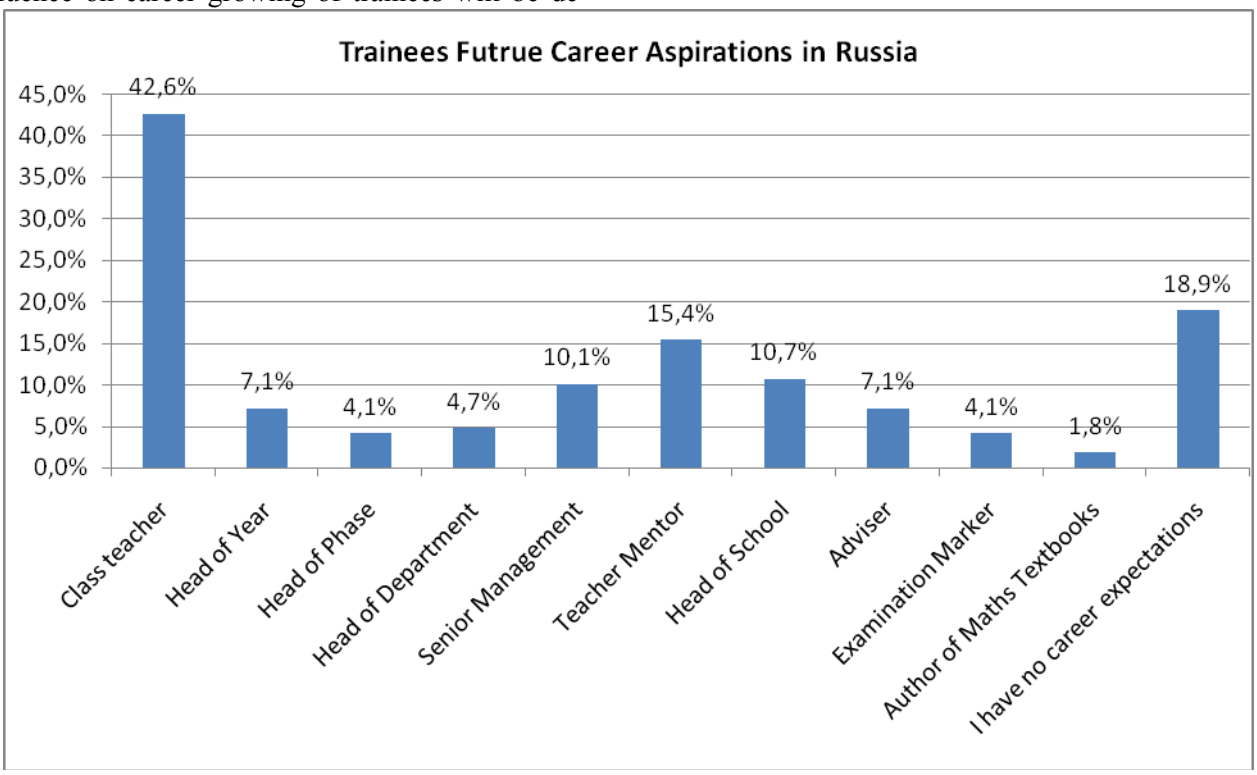


Fig. 10

Interview Data

We ask every Coordinators from Regions (Vologda, Yaroslavl, Perm) to define and interview of 3 trainee teachers which being secondary or primary trainees and have reached on short period of first year some positive and visible results in teaching process. Although we interviewed only a small sub sample, all being secondary and primary trainees was under supervising of school mentors and school administrations. We have summarized the main points below.

TEACHER TRAINERS

Some years ago (15 years) all the trainee teachers were in area of view by their University teacher trainer during a year. Trainee teachers had special planning of methodical, managing personal activity agreed with University and school administration. Now every trainee teacher defines his professional activity under the supervising of School. Administration of School appoints to trainee one of the qualified school mentor who should help NQT's to look on school documentation, to plan of individual activity (methodical, diagnostics, evaluation, research activity, communications), to study a good practice, modern pedagogical experience. School mentor should help to define interests and abilities of NQT's, promote of individual style forming of trainee, form the adequate evaluation of trainee's professional skills, to define problems in teaching process and methods of its escaping. *All trainees are very positive evaluated the role of school mentors in their adaptation and professional growing*.

GENERAL EDUCATION COURSES

General education courses are not typical for trainees; it is more suitable for administrators, teachers with experience. During general education sessions teachers with lectors discuss usually modern problems and methods of teaching mathematics, national standards and its implementations, good practice with elements of generalizations and so on. Modernizations of Russian educational system require to create the conditions for development of universal competence

of pupils and in-service teachers according modern tendentious.

PAIRED PLACEMENTS

There is one problem for NQTs in adaptation process to teaching mathematics. Young teacher (NQT) goes on open lessons of qualified teachers, but they have some uncertainty in applying of good experience. In this situation if another young teacher had good practice in teaching mathematics and first NQT have looked lessons, he understand that it is also possible for him. So it is very important for NQTs *to observe some lessons of other successful trainees*.

Анализ и интерпретация данных международного лонгитюдного исследования

In Russia mathematical training of Primary and Secondary teachers are strong differ. National standard of Primary mathematics is not included high sections of mathematics usual for Secondary, concern with *high levels of abstraction* (functions of several variations, differential equations, functional analysis, theory of complex functions). Another hands the level of *scientific thinking* of Primary students is really had more lower than Secondary one. These two factors are most influence on difference of mathematical cultures of Primary and Secondary trainees. On 2009 year Russia have involved new National standard on Primary education based on competence approach. National standard is based on three blocks of requirements: to contents of educational program, to conditions of applying (resources, techniques, finances, ..), to competences of pupils. The main directions of mathematical education [2]: personal development (logical, geometrical and symbolical thinking, proving skills, information search), methodology (universal actions of learning, modeling and analysis of real situation, planning, assessment), mathematical habits (numbers, operations, geometrical figures, data analysis). So should be difference between means of Primary and Secondary on mathematical cultures.

The comparison with other countries is best illustrated through the means on Primary (Part B) and Secondary (Part A):

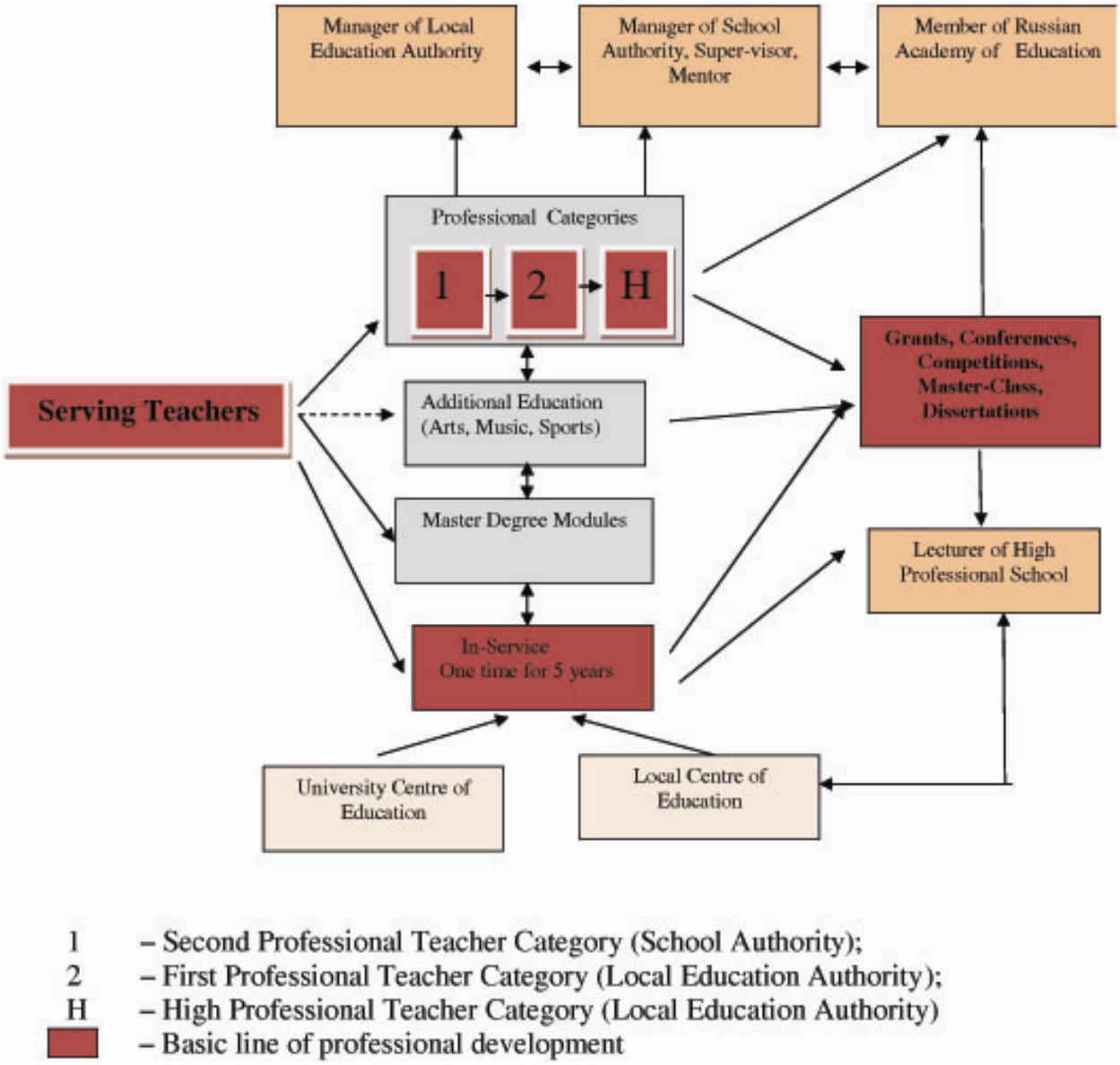
Table 2

	Secondary Audit Means (Part A)	Primary Audit Means (Part B)	Means	Difference
China	16,6	13,0	**14,8 ***	**3,6 ***
Czech Republic	14,9	7,7	11,3	7,2
England	14,1	6,8	10,45	7,3
Hungary	14,8	8,4	11,6	6,4
Japan	16,3	**15,9 ***	**16,1 ***	**0,4 ***
Russia	**17,3 ***	11,2	**14,25 ***	6,1

At first sight, the data for Russia Secondary Audit is the best , but for Russia Primary Audit is not so good (one of the first three positions). As we mark some problems in Russia for Primary trainees concern with *special attention which should paid to algorithms and calculating procedures, modeling of real process, operation with integers, nonstandard situations* in teaching mathematics. We think that China and Japan data in this Parts do not looks typical for teacher training and can be explained by very special conditions, concern with traditions in these countries (* – special extreme blocks) .

Continuing Professional Development

Teacher training in Russia historically has different opportunities for serving teachers up to continuous professional development (CPD). The following drawing gives the range of possible opportunities that are usually available for teachers in Russia.



Drawing 2. Continuous professional development of teachers

Ministry of Education and Local (Region) Administration pay for CPD work. According to National Law the teacher should be CPD by different ways: in-service once for 5 years; participating in School Professional Society; getting of 1, 2, H – Professional Categories; applying to Research Grants; Competitions (Local or National); Didactical Seminars at University or Local Education Centre; participating in Conference (National or International) and publication of articles; participating in Research Projects (National or International) and so on. In common CPD work takes approximately ***20 days*** per year. Every school in Russia has School Professional Society (**SPS**), which collect for didactical and research activity all serving teachers at school. The Council of **SPS** consists from teachers of high qualification, school administration , heads of problem groups and methodical groups. **The main tasks:** diagnostic work concerning with methodical resources at school; developing of new educational technologies; creating and managing of creative groups of teachers (including the special activity of school mentors with young teachers); defining the forms, methods and contents of CPD of teachers; planning, managing, regulation of professional activity of teachers (lesson study, methods of teaching, evaluation, clubs, competitions, Meetings, Scientific seminars and Conferences and so on), analysis and assessment of results; learning and adapting of New National Standards and Curricu-

lum; *6 stages of good practice*: learning and evaluation of educational practice , analysis and generalization, improving and dissimilation of good practice, supporting of teacher's individual style of development; diagnostic and statistic of educational process and pupil's attainments. Results of School-Based professional development of teachers (in common): High PC – 15-50 %, 1 PC – 25-40 %, 2 PC – 20-30 %, NO – 0-25 %. *University Centre of Education* organizes the in-service for regional teachers. At the same activity has been having for Local Education Authority, but teachers have a choice of Institutes. *Local Centre of Educational Quality and Assessment* manage the process of getting of teachers professional categories (1,2,H), quality of pupil's attainments, made of monitoring, statistic and diagnostic of educational process in primary and secondary schools. *Institute of Education Development* organizes Seminars, Conferences, Open Lessons, Competitions, Local Grants for good practice for regional teachers. *Ministry of Education* define Competitions, Research grants for teachers and schools, the nomination Teacher of a Year, manage of passing for International and National Projects and Assessment companies. In common teachers have some small addition to salary for getting of professional category (from 10 % to 25 %) or master degree; opportunity to prepare and realize the Open Lesson; improving in educational practice of school new forms , methods and technologies; involving of teachers in creative, managing work on Curriculum, diagnostics, analysis of educational process in problem groups.

Issues

In 2003 Russia signed the Bologna Declaration and until 2010 we should be part of the European educational area. In short, we must move toward a multilevel system of education (Bachelor and Master degrees) that includes teacher training. It is a problem for Russia. The most teachers for Primary and Secondary schools are prepared in Pedagogical Universities and Institutes (more than 80 %). As we saw on *table 1* that near 60 % of Secondary NQT's and 80 % Primary NQT's go into teaching directly after training. It is true that only 5-10 % classical Universities trainees became teachers. New approach will lead to *late motivation* on teacher profession (after Bachelor degree) and *shorter period* of vocational education (one year). Some problems of such approach can be compensated *more longer period of trainees* under supervising of qualified mentors. However historical analysis states hypotheses about *weak creativity* of such NQT's. It will be very interesting to compare these positions looking on Russian and European teachers because it seems that European teachers are prepared using such approach. Now our Ministry of Education do not have detailed program to modernization of teacher training, but Pedagogical Universities try to hold the most positive tradition of Russian teacher training.

However the testing inside ICSMTT show that there are positive and negative points in our educational system of teacher training.

There are positive positions:

– *Our strong conviction* which is supported by Russian responses on TAQ that NQT's should have the first priority as "to manage of mathematical knowledge" in teaching process. It was confirmed the best results of Russia Secondary Mathematics Audits;

– School administration tries to create for trainees' *conditions forming the individual style* of teaching and wide opportunities for career growing. We systematically remark sustainable percentage of teachers who try *to be Ph.D. and make scientific research*;

– It is tradition in Russia educational system to appoint the school mentors for every trainees TD, which help to defining the area of NQT's methodical activity and diagnostic of initial teaching experience: skills, evaluation, problems and so on. Moreover some of TD teachers became qualified teachers (nominated on first or second category) during their first year of teaching. *All trainees are very positive evaluated the role of school mentors in their adaptation and professional growing*;

– *Professional standard of pedagogical activity of teacher (PPS)*, which was created in Russia on 2007 under supervising of very famous psychologist V. Shadrikov is basic landmark for trainees to define ways of professional development. Indeed *PPS* is proved using and generating the good practice of teachers, valid and psychological laws of pupil's development. So it can define the main positions which will be addressed to trainees by their training courses;

– The best results of Primary trainees (82,5 % are involved in education area) have been explained by *these professional activity as part time* 's good practice in kinder gardens or primary schools during training period at University. Also we remark that a half of Primary graduates came to University after Pedagogical College.

There are some problems concerned with teacher training in Russia which appeared by analytical way of trainee's responses":

– The status, salary and morale of the teaching profession in Russia is low: many trainees leave school after only one or two years training;

– It is true this moment we have strange situation than future teachers can to enter in University without suitable motivation, mathematical abilities and special thinking. We think this situation will come to some problems of *links actualization between school and high mathematics* in teaching process;

– Analysis of real situation with Primary student's skills (tutor's interview, exams, applications and correlation) has defined the problem points: real numbers should be learned more deeply *with different kind of representations* (R. Dedekind, G. Kantor, K. Weierstrass) *and using the practical skills*; our students have very small ability to *solve problems in nonstandard situation* (reflection relatively invisible point, limiting theorems of probability and so on);

– It seems that the quality of mathematical skills and competence of future Primary teacher will be upper if *special attention paid to algorithms and calculating procedures* in teaching mathematics. So it is very important for NQTs *to observe some lessons of other successful trainees;*

– Trainees did not feel confident in "Probability" – 32,0 % and "Statistics" – 30,8 % because stochastic line in school mathematics was involved only some years ago in Russia and learning of stochastic require from pupils a good potential skills in modeling of real process what always was a problem for Russia;

– Student's responses show that special activity in teaching mathematics really must be created using some integrative courses and constructs, research activity in vocation area following to student's interests and experience. Trainee teachers lack the desire to use new methodologies and new mathematical knowledge to strengthen the efforts of their teaching. Knowledge and methodological skills are formal and have little application to real life;

– Big problem with "Geometry" – 35,5 %, where trainees did not feel confident. So starting from R. Descartes, it is concern with developing of pupil's thinking and hypothetical opportunities to apply geometrical knowledge. However an integration of geometrical, analytical, algebraic, stochastic and information knowledge in teaching mathematics using different resources will be a good practice to make topics more confident for students.

In Russia mathematical training of Primary and Secondary teachers are strong differ. National standard of Primary mathematics is not included high sections of mathematics usual for Secondary, concern with *high levels of abstraction* (functions of several variations, differential equations, functional analysis, theory of complex functions). There are some breaks between fundamental training and vocational study, especially when mastering methods of teaching mathematics and elementary mathematics. Another hands the level of *scientific thinking* of Primary students is really had more lower than Secondary one. These two factors are most influence on difference of mathematical cultures of Primary and Secondary trainees. On 2009 year Russia have involved new National standard on Primary education based on competence approach. National standard is based on three blocks of requirements: to contents of educational program, to conditions of applying (resources, techniques, finances, ..), to competences of pupils. The main directions of mathematical education: personal development (logical, geometrical and symbolical thinking, proving skills, information search), methodology (universal actions of learning, modeling and analysis of real situation, planning, assessment), mathematical habits (numbers, operations, geometrical figures, data analysis). So should be difference between means of Primary and Secondary on mathematical cultures.

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