University-School Cluster as an Environment for Teacher Professional Competency Development

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Abstract. The paper discloses relevancy, aim, scope and technologies of experimental activity conducted by the HSE—Perm to set up the University-School Cluster as an innovative form of enhancing Perm Krai teachers' professional competencies. We describe organizational structure of the cluster, determine unique features of applied forms and techniques of collaboration between participants (school and university teachers), and analyze the outcomes of the University-School Cluster activities at the first stage of the cluster development.
We consider the innovational aspects of cluster-based activities to be: advanced information and engineering support of subject-matter departments; development and implementation of a special technology to monitor the level of teachers' subject-matter competencies through the whole project; individual tutorial supervision of the teacher subject-matter competency enhancement process; development of the University-School Cluster website, an integrated interactive space for project members, and filling it with appropriate methodological materials

Keywords: teachers, professional education, subject-matter competencies, University-School Cluster, personal operation flow chart.

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The new model of university-school interaction

The end of the 20th century witnessed the start of fundamental changes at schools of the Western World. The changes were prompted by emergence and rapid development of a new branch of science studying education. Earlier, education had been merely regarded as a field of activity, but the 1970s turned it into an object of interdisciplinary interpretation and research. Various aspects of education became the focus of philosophical anthropology, sociology, psychology, eco-

nomics, computer science, and other sciences. Conventional didactics was suspended to give birth to learning sciences.

Learning sciences study what student is doing in the process of learning and analyze chances of developing self-learning, self-control and self-management skills. This is about creating a new learning culture to allow children develop themselves, while relying on school. This culture forms ability to construct 'personal' knowledge required to switch from understanding the problem conditions to solving the problem independently. Instructionism ('Do as I do') in relationships between teacher and student is replaced by constructionism, where teacher plays a contrasting role of a subject-matter expert. This provides for another, 'constructor-expert' type of relationships.

Obviously, this change in the learning culture was a challenge for teachers, who had to turn from the source and translators of knowledge into subject-matter experts, i. e. learning experts. We were late to discover that countries leading in general education (those providing the world's best schools) had gradually replaced their teachers with four-year teaching degrees with holders of Master's degrees in specific subjects (physics, mathematics, history, literature, etc.), i. e. actually with subject-matter experts.

In Russia, challenge for the traditional teaching culture is intensified by the need to develop in students personal qualities that are not nurtured by the environment. It is no coincidence that the recently adopted Federal State Learning Standard of General Education gives paramount importance to achieving personality development, instead of proficiency in specific subjects.

The strategy of sociocultural modernization of education suggests that the school should develop a new Russian society. Education is regarded as a social institution, which coexists with other social institutions, while advancing and predicting development of the whole society. The educational system performs important functions, forming the system of values. Besides, it serves an agent of socialization, playing the key role in purposeful inculcation of norms, attitudes and behavioral stereotypes in Russian people and in accumulation of personal, social and professional characteristics that provide individualization, socialization and professional development of an individual [Asmolov, 2010; Tsirulnikov, 2010].

In the West, the concepts and content of school education reforms were generated inside the leading universities, by the top-rated research schools investigating education problems. In Russia, this function is assigned to the Russian Academy of Education and pedagogical universities, but most of them have been short of ideas over the past two decades. Meanwhile, the major reforms of the Russian school have been conceived in the Higher School of Economics (the Unified State Exam, the new business model) and Moscow State University (academic competitions, the Federal State Learning Standard), which belong to national research universities.

Perm branch of the NRU HSE had long been searching for an effective Russian model of university-school interaction, in the sense of both the new teacher role (teacher as a subject-matter expert) and the new type of the learning process relationship (student-constructor—teacher-expert). The idea was about voluntary association of schools with a university, where the latter is a center for building professional development programs for the teaching staff of the associated schools.

In Russia, ideas like that can only be implemented step by step, in view of, inter alia, the traditional distrust of school staff to 'intruders'. The distrust should have been overcome not by pressing but through demonstration of university district benefits provided by effective education programs. Almost five years were needed to reach a high level of trust between the university and the school staff and to make teachers and school administrators feel a high degree of responsibility for efficient participation in university district education programs. After five years of the project development, it was possible to replace one-time advanced training format with continuous forms of interaction between the university and the associated schools. That's how it was decided to turn the university district into a university-school cluster with the number of participants extended through personal contracts with professors from other Perm universities.

The university should have assumed intellectual leadership in fundamental modernization of general education by undertaking to:

- Provide human resources training and retraining.
- Update the content of general education.
- Monitor learning materials and take direct participation in their development.
- Conduct research (sociological, economic, psychological, legal, managerial) in the education field.
- Monitor quality of the learning process [Lyubimov, 2005, 2006, 2007, 2011].

The long-term innovative education project "University-School Cluster" was launched in 2009 under the academic advising of Lev Lyubimov.

In our experiment, cluster refers to an organizational form where the parties concerned join their efforts to bring competitive advantages to the general education system. The most important result of creating clusters is that the education market is driven by a community of highly motivated players, instead of individual agents [Migranyan, 2002].

Relations that occur inside the cluster, often absolutely unexpected ones, lead to development of nontrivial techniques for competition and generate exclusively new opportunities. Human resources and ideas form unexplored combinations; the cluster becomes a

means of overcoming obsession with internal problems, inertia and stiffness that reduce or even block the positive effect of competition.

Working on a problem, members of the education cluster develop themselves and each other, building strong bottom-up partnership relationships that enhance competitive advantages of individual participants and of the cluster as a whole.

In fact, the University-School Cluster is an innovative form of providing professional teacher development and education quality management in the educational institutions involved.

Stages of Perm Krai University-School Cluster development

The three stages of the University-School Cluster development involved teachers and students of Perm Krai educational institutions that were competitively selected based on the level of their preparedness for innovative activities, as well as professors from three Perm universities: Perm State National Research University, Perm State Pedagogical University and NRU HSE—Perm. The number of educational institutions, teachers and students participating in the 2009–2011 University-School Cluster is specified in Table 1.

As seen from Table 1, the number of educational institutions in the cluster increased by 2.5 (53 Perm Krai educational institutions of various profiles) by 2011, i. e. by the 3rd stage of the innovative education project development, while the number of teaching members doubled (405 specialist subject teachers). At the same time, the University-School Cluster embraced the majority of educational institutions included in the NRU HSE university district (39 out of 42).

Organizational structure of the University-School Cluster is centered around the project group (Figure 1) which determines strategy and tactics of the cluster activities and provides successful implementation of the project in the current educational environment.

The cluster project team sets the key objectives and areas of activities, provides organizational and engineering support of all structural subdivisions of the cluster: 4 subject-oriented departments (teachers of mathematics, Russian, English, history and social theory), the monitoring team, and the web team.

In 2009–2011, the key University-School Cluster objectives included the following:

1) Develop, implement and enhance techniques of improving teacher professional competencies (in subject, project, information and communication planes), in accordance with the relevant needs of the Perm Krai teacher community.
2) Monitor consistently the process of teacher subject-matter competency improvement.
3) Organize and provide content for ad-hoc commands in the context of problems and technologies in modern education.

Table 1. **Participants of the innovative education project "University-School Cluster" in 2009–2011**

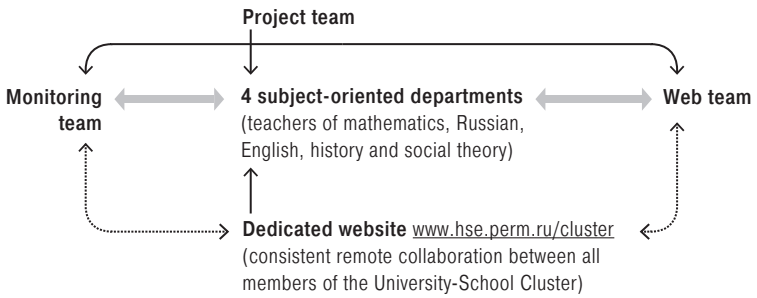
1st stage of development, 2009	2nd stage of development, 2010	3rd stage of development, 2011
Number of educational institutions		
22 educational institutions of Perm Krai (11 educational institutions of Perm, 11 educational institutions of Perm Krai)	55 educational institutions of Perm Krai (33 educational institutions of Perm, 22 educational institutions of Perm Krai)	53 educational institutions of Perm Krai (29 educational institutions of Perm, 24 educational institutions of Perm Krai)
Number of teachers		
212 specialist subject teachers	420 specialist subject teachers; 615 participants of network education projects	405 specialist subject teachers: 102 teachers of mathematics; 103 teachers of Russian; 119 teachers of English; 65 teachers of history and social theory; 16 teachers of economics
Number of students		
100 final-year students—members of the Social Leader School	91 final-year students—members of the Social Leader School	
Partner universities		
NRU HSE—Perm (organizer and intellectual sponsor of the project), PSNRU, PSPU		

4) Develop and upgrade the technique of efficient remote collaboration between cluster members through the specifically designed website.
5) Constantly replenish virtual learning and methodical resources of the University-School Cluster available for use by the Perm Krai teacher community.

Each stage of the University-School Cluster development has its specific features. In 2009–2010, these were:

- Forms and techniques of activities integrated with the renewed regional system of teacher professional development.
- Possibility of individual professional advancement with tailored tutor support for teaching members of the University-School Cluster who had the highest level of motivation for professional development.
- Participation of cluster teachers in digital learning resources competitions.
- Social Leader School's activities designed to develop the key supra-subject learning competencies (associated with social cul-

Figure 1. **Organizational structure of the University-School Cluster in 2011** (3rd stage of development)



ture, communication and management) among final-year students of the cluster educational institutions.

- Development and testing of network education projects designed to solve acute problems of modern-day teaching practices.

In 2011, the cluster was characterized by the following:

- Transformation of the social theory department into a history and social theory department.
- Improvement of the motivation and stimulation system for project members by means of issuing nationally recognized documents—certificates of advanced training—upon successful completion of the 102-hour program.
- Propaedeutic seminars designed to enhance information and communication competencies of the project participants by teaching them distant technology applied in the University-School Cluster format.

In 2011, activities of the four University-School Cluster departments were focused on developing and implementing supplementary professional education programs on the common theme "School Education Quality Management" for each subject: mathematics, Russian, English, history and social theory, economics.

Five education programs were successfully developed and implemented, each lasting for 102 hours (of which 50 hours were devoted to in-class learning, and the other 52 to learning with the use of remote learning technology on the dedicated cluster website).

To ensure effective implementation of the education programs, each department elaborated:

- Scheduled task sheets for teacher's cluster activities, describing in detail all the activities, topics of learning, tasks, terms for their completion, hours, forms of interaction with tutor, types of teaching procedures, milestones, and forms of control.

- Sets of competency-oriented tasks compiled in compliance with the USE (Unified State Exam) and the SFE (State Final Examination) requirements and with subject-specific troubles of teachers revealed through consistent monitoring.
- Teacher assessment charts, first used in the cluster format in 2011.
- Personal operation flow charts for at least 20% of teachers in each department;
- Learning and methodical complexes for five live theoretical and practical seminars conducted in activity-based format.

Personal operation flow charts

The cluster allows for optimization of professional development through *personal operation flow charts* for specialist subject teachers. These flow charts include:

- Basic information on the teacher.
- Results of measuring the level of teacher subject-matter competencies presented as a comparative chart including scores of acceptance test, three intermediate tests, and final test.
- Tutor's recommendations on working out an individual plan for teacher professional self-development.
- Individual schedule of cluster-associated teaching activities.
- Results of participation in development and implementation of an individual or team education project.
- Results of live and web-based consultations with the tutor.
- Analysis of the individual plan performance (intermediate and final results).

Tutors (department teachers) monitored development and improvement of teachers' subject-matter competencies within the frame of personal learning trajectories and amended individual plans depending on the task results on a regular basis. Competency-oriented tasks were compiled for each teacher with regard to variable-based approaches to learning and provided correction and enhancement of proficiency in subject-matter teaching skills. The tasks were oriented at step-by-step training in troublesome areas, while detailed outcome analysis provided for an overview of mistakes committed by the teacher in a specific task, as well as for consistent modeling of material handling processes through transfer of personal and professional experience from tutor to teacher.

Possibility of working in the *personal learning trajectory* format for teachers with a high degree of motivation for professional activity and development provides some clear benefits, both operational and content-related. For example, teachers are free to select subjects of their profound studies and problematic fields to work on with their tutors. Therefore, the uniform education program can be modified and customized according to personal learning trajectories. Besides, tu-

tor and teacher can interact vis-à-vis in their own group on the cluster website. A small subject-matter group like that offers confidential, individually focused professional collaboration, which is deeper than in a common subject-matter group. A teacher who chooses to follow an individual learning trajectory may opt out of working in the common subject-matter group. Measurements of subject-matter proficiency may also vary (by type and volume of tasks, time for completion) at tutor's discretion and with regard to teacher's propositions.

Distant and live working formats

Successful implementation of programs was largely provided by the *distant working format* applied in the cluster, with the focus on individual learning mode for each teacher supervised by a tutor.

Non-conventional, mostly distant working mode for the same teaching staff during a long period of time required that each tutor and professors of each department changed their traditional teaching methods used in advanced trainings (lectures, practical classes, consultations, etc.). The highest efficiency was demonstrated by the following strategies of subject-matter departments:

- Focus on education program issues that create difficulties for the specialist subject teacher. Such issues became the talking point at practical seminars and the subject of analysis and discussion in the remote collaboration mode. This strategy of building an education program proved efficient both for development and extension of subject matter competencies and for keeping up teacher motivation for working in the cluster for the whole period of learning.
- Consistent monitoring (acceptance, intermediate and final) of subject matter competency dynamics through live and web-based testing with immediate results and through various tasks covering the key milestones of education programs.
- Analysis of intermediate teacher proficiency monitoring results; diagnosing the troublesome areas.
- Customized teacher-tutor collaboration; identification of topics and units of subject-matter courses that cause difficulty for the specific teacher motivated for professional self-improvement; regular face-to-face review and analysis of mistakes made by the teacher in tests and examinations; detailed tutor comments on difficult or controversial points from various parts of education programs.
- Development and implementation of personal and team education projects designed to help each teacher solve local problems in their institutions associated with educational process organization.
- Everyday real-time communication between tutors and teachers through the dedicated cluster website http://www.hse.perm.ru/cluster/ on various aspects of learning, whether related to the

subject matter or to the teaching techniques or to the process organization.

The level of motivation and activity of teachers in the cluster was largely influenced by *live theoretical and practical seminars in the interactive format*. For each of such seminars, teachers of subject-matter departments developed learning and methodical materials which were later uploaded to the cluster website to be thoroughly analyzed and implemented by the teaching community in the process of their professional self-development. Apart from recommended thematic reading lists offered at each seminar, teachers were enabled to work with relevant, controversial and disputable information, with diverse types of competency-oriented tasks.

Through active participation in the seminars, teachers learned some of the modern teaching techniques, such as interactive teaching methods, project technology, case study, critical thinking development, or technique for modern-day lesson planning and analysis.

The key specific feature of cluster-format theoretical and practical seminars in 2011 was discussion and presentation of intermediate and final results of *personal or team education projects* developed and implemented by teachers. These projects became one of the ways to assess teacher's cluster-associated activities.

We understand educational projection as teacher's activities associated with identifying problems in teaching practices and constructing methods of their solution with limited resources within a limited period of time.

The cluster project team set the following project goals for teachers:

- Identify the key problems in teaching practices of the University-School Cluster educational institutions and find appropriate solutions.
- Enhance effective project activities within the teaching community.
- Create a bank of teaching innovations to systematize the major products of the project for their subsequent implementation in the teaching process;
- Grant certificates to the most active educational projection players.

Motivation of teachers and their performance in education program implementation were boosted with the help of *teacher assessment charts* posted on the cluster website and updated on a monthly basis. The cluster first used this method in 2011.

The assessment charts contained relevant, transparent and unbiased information on results of all tests and tasks taken by teachers, clearly distinguishing between leaders and those dragging behind.

The cluster project team compiled assessment charts and sent them over to administrators of cluster educational institutions, so that

they could analyze the data and make managerial decisions concerning performance of each teacher in the cluster. Use of assessment charts allowed for a positive competition among teachers of the cluster and for a strict reporting format.

Having analyzed the data presented in teacher assessment charts, departments and the cluster project team decided on granting state-recognized certificates of advanced training to teachers who had successfully completed the 102-hour education program. 279 teachers of subject-matter departments obtained certificates in the final seminar, while the 224 most active and efficient seminar participants were granted diplomas and certificates of the Ministry of Education in Perm Krai and the NRU HSE—Perm.

Testing teacher subject-matter competencies

To perform consistent monitoring of teacher subject-matter competencies (five tests during the project), we used a special technology developed by professor A. P. Ivanov and S. A. Kozlov, head of the internal quality audit department of the NRU HSE—Perm. High efficiency of the applied technology was provided by its unique features: possibility of remote monitoring; processing and presenting test results within one hour; automatic import of distant test results to live test results; automatic generation of eight test versions out of two source versions.

Each test in each specific subject included at least 30 tasks and had at least two source versions (for further automatic generation of eight or more versions). Testing was performed using specifically designed electronic answer sheets.

Results of each test were presented in graphs, individual score charts and rankings of specialist subject teachers, as well as in teacher subject-matter competency growth charts. After the test scores had undergone computer processing, each teacher received detailed information on their test results with mistakes corrected.

Regular testing allowed each specialist subject teacher to correct immediately their plans for professional self-development, based on the quality of test performance. Troublesome areas revealed in the tests were addressed specifically during the correction process. Tutors of each subject-matter department compiled in-depth commentaries to each test version.

Thus, the custom-tailored technique allowed to assess impartially the dynamics of subject-matter competencies of each teaching member of the University-School Cluster.

Table 2 shows comparative indicators of teacher subject-matter competency growth at three stages of the University-School Cluster development (2009–2011). Quality of test performance among specialist subject teachers increased significantly within the period of cluster collaboration, the average growth rate based on the final test results being 13.8%.

Table 2. **Comparative indicators of teacher subject-matter competency growth at three stages of the University-School Cluster development (2009–2011)**,%

Subject-matter department of the cluster	Type of test (quality)						Average growth rate based on the final test results		
	Acceptance test			Final test					
	2009	2010	2011	2009	2010	2011	2009	2010	2011
English	61.6	62.5	62.5	73.6	70.5	72.4	14.3	8.7	8.6
Mathematics	51.6	35.9	57.6	83.7	60.5	66.6	32.9	25.6	8.9
History and social theory	63.9	68.9	65.0	75.5	79.1	76.0	12.7	5.5	8.2
Russian	78.8	35.3	49.0	89.6	49.8	59.1	11.4	13.6	9.1
Primary school	57.6	31.7	—	68.8	52.5	—	10.6	20.4	—
Total teacher subject-matter competency growth rate at stages 1–3 of the University-School Cluster development							16.8	15.8	8.7

Table 3. **Self-assessment of performance in the education project "Development of the University-School Cluster (an innovative community of Perm Krai educational institutions) in 2011"** (max. 10 scores)

Analysis parameters	Department				Teachers of economics	Total
	mathematics	English	Russian	history and social theory		
Number of respondents	51	55	56	18	5	185
1. Activity of teachers in the cluster	9.1	8.2	7.4	7.9	7.6	8.0
2. Motivation for working in the cluster	8.8	9.0	8.3	8.6	8.4	8.6
3. Factors affecting the level of teacher motivation and activity in the cluster						
3.1. Granting state-recognized certificates of advanced training	9.2	8.8	9.1	7.7	9.0	8.8
3.2. Granting diplomas and certificates based on performance in the cluster	9	8.5	9.2	7.8	9.6	8.8
3.3. Using template documents—teacher operation flow charts and teacher assessment charts—in the process of advanced training	8.9	8.2	8.5	7.9	8.7	8.4
3.4. Consistent professional interaction with department tutors and performing competency-oriented subject-matter tasks in live and web-based formats	9.7	9.2	9.3	8.5	9.4	9.2
3.5. Consistent monitoring of the process of teacher subject-matter competency improvement (five types of tests)	9.4	8.8	8.5	7.7	8.6	8.6

Analysis parameters	Department				Teachers of economics	Total
	mathematics	English	Russian	history and social theory		
3.6. Participation in five live theoretical and practical seminars held in the interactive format	9.0	8.8	8.1	8.9	8.9	8.7
3.7. Possibility of advanced training in the personal learning trajectory format	9.5	8.6	8.7	8.1	8.4	8.7
3.8. Possibility of using learning and methodical materials of the department databank uploaded on the cluster website	9.7	9.3	9.0	9.0	10.0	9.4
3.9. Control over the quality of cluster-format advanced training by administrators of educational institutions	5.8	7.6	7.0	5.0	5.5	6.2
3.10. Collaboration with colleagues and exchange of professional experience within the cluster	8.4	8.2	7.4	6.9	8.4	7.9
3.11. Mostly distant interaction between cluster members through the dedicated website	9.7	8.9	8.7	7.6	9.0	8.8
4. Subject-matter competency growth	9.8	9.8	9.6	9.5	10.0	9.7
5. Efficiency of cluster-based forms of interaction						
5.1. Regular testing of teacher subject-matter competencies	9.7	9.3	8.9	8.8	9.6	9.3
5.2. Working within a personal learning trajectory under supervision of a personal tutor	9.6	8.1	9.0	8.2	8.9	8.8
5.3. Working in a subject-matter group of teachers under supervision of a department tutor	9.3	9.0	9.2	7.7	9.4	8.9
5.4. Participation in live practical seminars	8.8	8.6	8.8	8.8	9.2	8.8
5.5. Live and web-based consultations with department tutors	9.2	9.0	9.1	8.1	9.4	9.0
5.6. Working on development and implementation of an individual or team education project	8.3	8.8	8.0	7.3	8.7	8.2

Outcomes of the University-School Cluster activities

In order to analyze performance of the University-School Cluster in increasing the level of teacher subject-matter competencies at the 3rd stage of development and to determine the main lines of improvement in the future, we conducted an opinion poll (with specified quality parameters) among all specialist subject teachers in the final live seminar. Table 3 contains systematized results of the poll.

Analysis of points given by teaching members of the project to assess 20 parameters of cluster-associated activities allows to identify the average level of the University-School Cluster performance in 2011. In the teachers' opinion, the average value is 86.4%, which

demonstrates that the project is unconditionally recognized as highly efficient by its direct participants.

As the teachers see it, the key benefits of the University-School-Cluster as a form of advanced training are as follows (the top-ranked ones):

- A highly comfortable and efficient modern interactive form of learning based mostly on distant interaction (possibility of combining work and study and performing tasks at any time).
- Highly professional tutor supervision (timely and quality consulting on all training subjects, opportunity to ask questions and receive answers 24/7, relevant and demanded seminars in the activity-based format).
- Possibility of systematizing, deepening and upgrading subject-specific knowledge and applying the acquired learning and methodical base in the learning process to improve subject-matter competencies of students.
- Adopting modern teaching methods and techniques adjusted for use in the school learning environment.
- Engagement in professionally oriented network interaction to exchange experience with colleagues and to provide expert assessment of learning and methodical materials and results of innovative project activities.

Based on the outcomes of participation in the project, teachers developed ideas to enhance efficiency of the University-School Cluster activities:

- Allow more time for education programs implemented in the University-School Cluster format.
- Keep learning modern teaching techniques with continuous tutor supervision.
- Strengthen practical focus of subject-centered learning.
- Offer more creative, design and research tasks to teachers.
- Hold open lessons and workshop sessions within the cluster framework to demonstrate how teachers can apply acquired knowledge in real-school conditions, teaching real students.

As we see, the innovative form of enhancing professional competencies of teachers in the University-School Cluster format at three stages of the cluster development proved to be highly efficient. The 'tutor-teacher' system of professional collaboration developed in the cluster provides for a qualitatively different teacher training, as fundamental basic professional knowledge can now be combined with cutting-edge teaching techniques, thinking skills development and research approach to solving specific education problems. Indeed, the form of teacher competency improvement, which was tested thrice in

the cluster, helps train highly qualified teachers who are competitive in the labor market, proactive, thinking critically, capable of finding efficient solutions to sophisticated problems of the modern-day school, longing and striving for a continuous professional growth.

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