

## Creating Integral Learning Environment for Training Mathematics Teachers under Continuing Education Conditions

<sup>1</sup>Everstova Valentina Nikolaevna, <sup>2</sup>Ivanova Avgustina Vasil'evna,  
<sup>2</sup>Bugaeva Aya Petrovna, <sup>1</sup>Popova Alena Mikhailovna and  
<sup>1</sup>Makarova Sargylana Mikhail-Lovna,

<sup>1</sup>Department of Teaching Methods in Mathematics,  
Institute of Mathematics and Information Science,  
North-Eastern Federal University in Yakutsk, Yakutsk, Russia  
<sup>2</sup>Department of Elementary Education, Teacher Training Institute,  
North-Eastern Federal University in Yakutsk, Yakutsk, Russia

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**Abstract:** The main challenge in training modern teachers of Mathematics is to optimize and improve the system of continuous education. This agrees with the basic principles of educational policy in many countries-participants of the Bologna agreement “training throughout life” that involves continuous professional education. Changes in modern Russian education have aggravated many challenges in training teachers as well, including teachers of Mathematics, because the conditions for developing continuous education (multiple-level system, succession, flexibility, sufficiency, integration) are understudied in the Russian science and practice. Besides, there is a great practical need to study, develop and define the ways to solve this issue. The authors set the following goals: to overcome the contradictions between the need of the society and education to train different, more modern specialists by creating a whole pedagogical process. The study have specified the notions of ‘continuous education’ and ‘integration at various levels of continuous education’. The training of future teachers of Mathematics is analyzed by continuous sampling method using the data of pre-professional and professional training and employment. The results have enabled to evaluate the current practice of training teachers of Mathematics to reveal the best ways to improve Mathematical education by strengthening successive links between education stages (elementary, secondary, higher and post-graduate) and to define the ways to integrate the content at various levels of education. We have found that integrative processes in the system of continuous professional education define the unity and wholeness of its educational space involving different stages of education. The study justifies the need to develop a theoretical model to reveal the creation and functioning of the whole education space involving pre-graduate training, professional education and post-graduate education of a teacher of Mathematics. We need further studies to define conceptual foundations of integration at different levels of continuous system of professional training for teachers of Mathematics.

**Key words:** Career choice, continuing professional education, integration, mathematics teachers, teaching practicum

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### INTRODUCTION

The transformations in contemporary Russian education have led, along with positive changes to further aggravation of numerous problems, including those related to training teachers and in particular, mathematics teachers, especially suffering from insufficient development of necessary conditions for continuing education (multi-level systems, continuity, flexibility, availability, integrative approaches). The existing practice

shows that the current situation with training teachers and the realization of educational processes does not comply with the level of society’s demand for teachers with such competencies as the ability to predict, design and organize substantive and procedural elements of education. This can be explained by the fact that the traditional system of teacher training is based on the knowledge-oriented approach which is further complicated by differences and lack of continuity in pre-university training, professional and postgraduate

education. There is a need to develop a system of continuing teacher education and identify ways of integrating the content of training programmes at different stages of education.

**Literature review:** The Federal Law 'On Education in the Russian Federation' came into force. It defines education as 'an unified purposeful process of upbringing and training which is a public good implemented in the interests of a person, family, society and the state as well as the body of the acquired expertise, knowledge, skills, values, experience and competence of certain volume and complexity for the purpose of intellectual, moral, creative, physical and (or) professional development and satisfaction of educational needs and interests of an individual'.

The fact that the new law replaced two earlier basic laws-'On Education' and 'On Higher and Postgraduate Professional Education' is another stimulus for teachers and professors of pedagogical educational institutions to look deeper into the issues of continuing education, the meaning and content of which have still not been clearly defined. Thus, the aim of this study is to identify ways to implement the concept of the continuing professional education system with integration of different stages of professional education for the training of the next generation of mathematics teachers.

Also, the purpose of this study is to find a way to resolve the contradictions between the needs of the society and ability of the educational system to train specialists on a more advanced level which requires joint efforts of all those involved in the continuing education system to develop and implement a comprehensive educational process. A review of the literature on continuing professional education confirms the availability of the necessary theoretical framework for further studies on the subject. The methodological and theoretical frameworks for the subject were developed in the works by Gershunsky (1998), Novikov (2002), Potashnik (1995), Feldstein (2012) and other researchers.

The issues of the professional education development were thoroughly studied and reviewed by Alferova (1998), Batyshev (2009), Shadrikov (2005) and other researchers. Their works provided substantiation of theoretical approaches to organisation of necessary conditions for continuing professional education. The principles, ways and conditions of the development of the continuing professional education system were studied in the works by Ananjev (1980), Novikov (2002) and other researchers.

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As Rimareva (2004) stated, the notion of continuity refers to 'a certain process or property of an object, characterized by the absence of gaps in its flow or transition from one qualitative state to another'. An interesting definition of the notion of continuing education was given by Kravchenko (2010): 'a gradual, lifelong process providing constant update and expansion of knowledge in people of different age's. He also identified two major phases of continuing education: in childhood and youth and in adulthood.

So, for the present research purposes the continuing education is understood as a systematic, unified purposeful process of upbringing and training people of different ages, ensuring their transition from one qualitative state to another. Such transition can be characterised both by vertical integration and by horizontal integration. The vertical integration implies the continuity of educational stages (primary, secondary and professional education, advanced training, etc). The horizontal integration is an association of various educational institutions and organizations.

The review of the literature on the subject provides for better understanding of the specific character of its development. Nevertheless, it is necessary to mention that the present-day concept of training a new generation of specialists can be only developed on a totally new basis.

## **MATERIALS AND METHODS**

**Training of future mathematics teachers:** The continuing professional education of mathematics teachers is aimed at training the next generation of specialists who are capable of creative work and not only have profound knowledge in their subject domain but combine general functional skills with high moral values. In order to train this new breed of teachers, it is necessary to integrate the content of training programmes at different stages of education. In his research the integration at different stages of continuing education is considered as a mean to create a comprehensive and progressive learning environment and ensure continuity of education and professional training aimed at maintaining the specialist competencies and their development on the basis of achievements at previous education stages.

The issue of continuing education implementation for the training of future mathematics teachers has been considered at the Department of Teaching Methods in Mathematics, Institute of Mathematics and Information

Science, North-Eastern Federal University in Yakutsk. The main stages of the preparation of mathematics teachers are:

- Pre-university training
- Professional education
- Postgraduate education

Let us identify the major issues related to training of future mathematics teachers, some of which are relevant already at the secondary education stage and consider possible ways to solve current problems in this sphere. A mathematics teacher takes the following steps on the path to a future career: career choice, pre-professional education, enrolment, training, teaching practicum, employment and work as a mathematics teacher.

**Step 1 (career choice):** A survey of the first-year students showed that the main reasons for choosing a major focused on teaching mathematics were the following:

- ‘I liked Algebra classes at school’ -39.3% of all respondents
- ‘My grades were too low to enter another higher education institution’ -32.2%
- ‘Job prestige’ -21.4%
- ‘I like the profession of mathematics teacher’ -10.7%

This means that only 10.7% of respondents made a conscious career choice and for 32.2% it was a random choice. Unfortunately, school leavers nowadays do not consider the salary of teachers to be sufficient (0%), though they consider the job to be prestigious (21.4%). Only after entering a higher education institution, some of the first-year students start asking themselves, ‘Have I made a correct career choice?’

**Step 2 (pre-professional education):** The next step in handling this problem is organisation of pre-professional education of schoolchildren. In compliance with the vertical integration principle, general education institutions of the Republic of Sakha (Yakutia) have concluded collaboration agreements with the University Department. Under the agreement provisions, members of the academic staff participate in the following activities: on-site tutorials in mathematics (involving University students), vocational guidance work in the schools of the Republic, mathematical competitions, research and application conferences and meetings with students.

**Step 3 (enrolment):** The next step on the path to the mathematics teacher career is enrolment in an institution of higher education (Table 1). As seen in Table 1, such

Table 1: Qualitative characteristics of students choosing a major focused on teaching Mathematics

Variables	2011	2012	2013	2014
Minimum grades in Mathematics	41.0	48.0	52	52.0
Maximum grades in Mathematics	72.0	68.0	70	80.0
Average score	55.4	58.3	61	64.2

indicators as the lowest grades and the average score in mathematics demonstrate an improving trend. However, it is necessary to attract more prospective university students with higher grades, because a school leaver entering university with the grade of 52 in Mathematics has not coped with any part C tasks during the Unified State Exam (USE).

The academic staff of the Department of Teaching Methods in Mathematics purposefully works together with teachers to promote outreach efforts in order to attract highly gifted and talented pupils of general education institutions. They conduct seminars and practical sessions to assist in solution of higher-level problems of the USE in mathematics and mathematical competitions, both for the teachers of the Republic schools and for schoolchildren. The first-year students encounter the following problem: the University has adopted an academic credit system, or Point-rating System (PRS) to measure student’s achievements, requiring a considerable volume of Unsupervised Learning Activities (ULA) and timely presentation of the ULA results to earn credits. Unfortunately, the school leavers are not used to self-organized activities and timely performance of unsupervised tasks, which can be explained by the fact that learning in schools is based on the subject and knowledge-oriented approach. As a result, many first-year students are expelled before or during the first examination period.

To assist the first-year students during their adaptation period, the most experienced members of the academic staff are appointed mentors who are actively promoting greater awareness of the related issues among students and academic staff and visiting student’s residence premises to assess their living environment. A very important area of activities is work with parents who send out the former schoolchildren to lead the independent adult lives.

**Step 4 (training and teaching practicum):** A significant role in the mathematics teacher’s formative experience is played by the teaching practicums all students pass in the general education institutions of the Republic of Sakha (Yakutia). Thus, the second-year students of the Mathematics Teaching Methods Department start attending introductory practicums at schools of the city of Yakutsk. The third and fourth year students must pass teaching practicums in the Republic schools. The analysis of teacher’s diaries showed that most mathematics teachers preferred traditional lessons with the use of

information and communications technologies. However, you can rarely see descriptions of lessons with the use of the advanced teaching technologies such as case technologies, problem-oriented training, quiz, interdisciplinary (“binary”) lesson, conference lesson, etc.

In order to create favourable conditions for high quality training of the future mathematics teachers through the development of the student’s research activities and their participation in research studies within the frames of the comprehensive approach to education and professional training, we run several student’s scientific circles at our department.

For example, we recently launched the scientific circle ‘Advanced training technologies at mathematics lessons and in extracurricular activities’, aimed at developing research and teaching programs for application of the advanced training technologies at mathematics lessons and in extracurricular activities.

In addition to teaching practicums, during the entire academic year our students attend lessons and extracurricular activities held both by mathematics teachers and teachers of other school subjects. They get acquainted with the advanced teaching practices, create plans of lessons and extracurricular activities, develop fragments of lessons with the use of modern technologies, analyse lessons, discuss their research results and participate in project activities, thus creating their own methodology and knowledge banks for the future work as mathematics teachers.

**Step 5: Employment and work as a mathematics teacher:**

The next stage is employment. It is where young specialists encounter serious problems, as many of them want to be employed in the city of Yakutsk while there is either lack of vacancies or school administrations seek only for developed specialists with a proven teaching experience.

**RESULTS AND DISCUSSION**

We have analysed the statistical data as on 01 September, 2013, provided by the Personnel Department of the Education Administration of the urban district ‘City of Yakutsk’ (Fig. 1). As seen in Fig. 1, the share of young specialists (up to 25 y.o.) is 3% (6 persons) and share of young teachers (26-35 y.o.) with a certain professional experience-17.7% (33 persons). The prevailing group includes teachers older than 50 year 42.3% (79 persons), with a somewhat smaller share of teachers of 36-50 year 36.9% (69 persons). There is an obvious trend of the teaching staff ageing in the urban district “City of Yakutsk”. Nevertheless, the schools of Yakutsk do not want to employ young specialists.

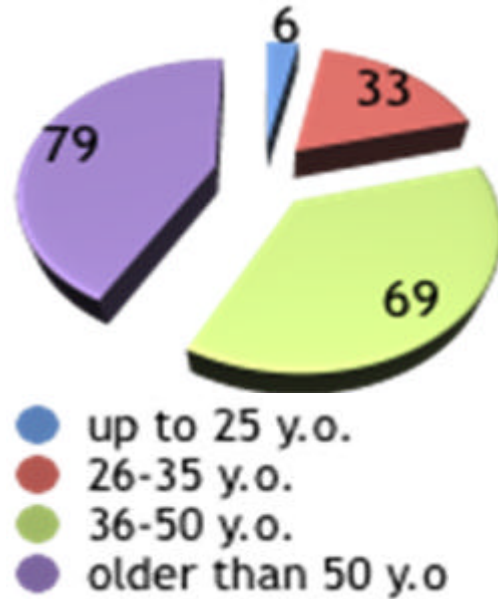


Fig. 1: Age of mathematics teachers in the urban district ‘City of Yakutsk’

Table 2: Employment of the Department of Teaching Methods in Mathematics graduates for the last four years

Variables	2012	2013	2014	2015
Number of graduates (full-time)	61	48	48	51
Employed in Yakutsk EI	3	7	3	2
Employed in EI in other republic regions	31	22	25	27
Share of students employed as mathematics teachers	55.7%	60.4%	58.3%	56.9%

During the 2012-13 academic year, the Department of Teaching Methods in Mathematics (Institute of Mathematics and Information Science, North-Eastern Federal University in Yakutsk) made efforts to help the Department graduates get jobs in Yakutsk Educational Institutions (EI). As a result, two girls who studied at our department were invited to work in the schools of Yakutsk where they passed the teaching practicum and they were employed there after the graduation and it is only one example. However, there are still certain problems with employment of our graduates which is confirmed by the statistical data (Table 2).

We do not forget our graduates working in the general education institutions and pay attention to them even after they leave the University. Every year, during the Teacher’s Week, we organise traditional meetings of undergraduate students with young teachers and renowned, most experienced teachers of the Republic where the young specialists tell about their first impressions of the career start and their senior colleagues share their experience of working both as mathematics

teachers and form masters and show the documents they use: curricula, syllabi, course schedules, handouts and teacher's portfolios.

Under scientific supervision of the Department of Teaching Methods in Mathematics (Institute of Mathematics and Information Science, North-Eastern Federal University in Yakutsk) the Department graduates organized a School of Young Mathematics Teachers (SYMT) in Yakutsk. Under agreement with the Methodology Department of the Education Administration of the urban district 'City of Yakutsk', the students attend the SYMT seminars, open lessons, master-classes and workshops held in the city of Yakutsk, get acquainted with the methodology and knowledge banks of their future colleagues, participate in round-table discussions and in organisation of municipal events, competitions, etc.

But we can see that the Department professional training efforts alone are not enough to optimize the learning environment-other effective mechanisms should be in place to solve the identified problems and in particular, it is necessary to deal with the following organizational tasks:

- To open specialized learning classes focusing on mathematics in the local schools
- To perform research activities on the basis of the Department of Teaching Methods in Mathematics in order to identify predisposition to teaching among teenagers and senior schoolchildren
- To introduce a point-rating system for senior schoolchildren in general education institutions

### **CONCLUSION**

The urgent necessity to solve the identified problems makes it vital to define the conceptual framework for the training content integration at different stages

of continuing education and the development of a theoretical model of creating and maintaining a functional integral learning environment, combining the pre-university training, professional and postgraduate education of mathematics teachers.

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