Dutch-Russian Double Degree Master’s Program Curricula in Computational Science and High Performance Computing

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Abstract— From the moment of the fall of the Soviet Union in 1991, Russian higher education underwent drastic changes to international standards and enter the European Higher Education Area on equal terms.

Joint efforts of Russian and Dutch peers and strong incentives from high-tech industries helped to launch new educational programs in Computational Science. Our international team of educators attempts to pick the best from the curricula and educational methods of post-Soviet programs and adopt the world’s best practices in engineering education.

In this paper we describe the curricula of a double-degree Master’s program in Supercomputer Technologies in Interdisciplinary Research of the ITMO University and the University of Amsterdam and newly-developed programs in Big Data and Urban Supercomputing. We comment on the form and content of our programs and give some examples of student research topics.

Keywords—curriculum design, computational science, Master's programs, double degree

I. INTRODUCTION

Progress in science and IT technologies set up new standards in education. New guidelines for Russian universities to comply with international standards [1], prescribe the use of a competency-based approach to change the preferable behavioral model of an educand from passive perception and reproduction of scientific facts to participation in collaborative knowledge co-creation activities.

To close this gap Russian universities longing to compete at the international market should develop much faster than European and US universities. Moreover these ambitious Russian institutions should not just blindly copy the benchmark experience of the leading universities, but to synthesize the best practices with Russian specificities, including the regional component.

This tendency calls for the existing curricula of the undergraduate (bachelor degree) [2], [3] and graduate degrees [4] to be redesigned due to:

- the fact that the existing content of engineering courses can’t keep up with the ever-changing technical progress,
- the not yet finalized adaptation process of the Russian education system to the requirements of the Bologna Process and
- the necessity of sparking creativity [5], especially for graduate students.

Saint Petersburg National Research University of Information Technologies, Mechanics and Optics (ITMO University) is one of the oldest engineering educational establishments in Russia and is recognized as the leader in informational technologies and optics. During the last decade ITMO University’s programming team was five times the world champion in the ACM International Collegiate Programming Contest [6]. At the present moment, the total number of students is about 15,000. Education of more than 73% of the total number of students is funded from the state budget. More than 600 ITMO University students are from CIS and foreign countries. In 2013, the university enrolled 1,300 graduates from schools and other educational institutions for
the first year of Bachelor programs and more than 1,540 people in Master's programs.

To promote and increase the efficiency of academic and scientific activity of Master and Ph.D. students and to diversify R&D in ITMO University, eScience Research Institute was created in 2007. The main specificity is the application of the methods of Computational Science and HPC in solving scientific and engineering problems in various domains ([7], [8], [9]). In turn, in 2010 to accentuate academic propagation of Computational Science a Department of High Performance Computing was organized with a focus on graduate studies.

Driving forces of long-term scientific collaboration between the University of Amsterdam (UvA), The Netherlands and ITMO University are historical and cultural ties. This collaboration is implemented in scientific projects and joint educational activities. Consequently on the basis of eScience Research Institute and the HPC department the first students of a double-degree Master's program in Computational Science [10] commenced their studies in 2012. The launch of this program, in addition to the design of two brand new Master's programs in HPC, became a unique experience for ITMO University in terms of (1) recognition of Russian educational initiatives at the European level, (2) delivery of Master's programs solely in the English language and (3) an amalgamation of diverse areas of engineering and social science in the unified content with personalized learning trajectories.

**PREREQUISITES TO THE CHANGES**

**National Trends**

One of the most important global trends in the development of education in modern society is the shift from the paradigm to control the process of mastering knowledge and skills to managing the development of human capital. Higher education in knowledge-intensive areas such as computational science should prepare alumnas who understand state-of-the-art in their field of interest. Unfortunately, continuing the traditions of the Soviet system, many Russian educators are bound professionally and mentally by the level of scientific and technical development in their native region. To address the demand of knowledge-based economy and interests of all the stakeholders (employees, parents, and future students), a strong drive to enter the international education market has appeared.

In May 2012 the Russian Ministry of Science and Education issued a decree that the nation should have at least five universities in the world's top 100 list in QS ranking by 2020. In 2013 the government announced a contest for subsidies among the leading universities, and ITMO University become a part of this federal program “5/100/2020” to improve the competitive advantages of Russian universities among the world’s leading educational centers.

Measures to move the universities higher up in the international rankings are, for instance, realization of joint and double degree academic programs with leading technical universities worldwide, invitations for guest lecturers from abroad, and the development of international academic mobility of students and staff, etc. To reach this ambitious goal a participation of foreign experts is required in the major aspects of performance such as the assessment and international accreditation of educational programs, scientific and financial activity of departments and the University as a whole, and defense of graduation theses and research projects. Although the importance of international experience for the modernization of higher engineering education is recognized everywhere, systematic involvement of foreign experts for this purpose is a recent practice for Russian universities.

**ITMO University Trends**

To take part in the competition for government subsidy ITMO University has prepared the Program of Competitiveness Growth until 2020 – a roadmap to improve international competitiveness [11]. The strategic goal of this roadmap is to achieve one of leading positions within the global research and educational elite by means of conducting advanced research in the field of convergent technologies (ICT, nano-, bio-, and cognitive technologies).

The principal advantage described in this document is the creation of Centers of Excellences at ITMO University to diversify its research and educational activities in accordance with given basic competencies (“product” specializations). Existing scientific infrastructure, including laboratories, shared use centers and research institutes of ITMO University will be merged into the Centers of Excellence, e.g. Intelligence Technology and Robotics, Life Sciences and Healthcare, Information Technologies for Economics, Sociology and Arts, Smart Materials and Photonics and Natural Science (see Fig. 1). Creation of Centers of Excellence at ITMO University should help to bring in line with the indicators of leading foreign universities, the volume of international research, the number of publications, citation index, patents, etc.

Research activity is an essential tool for generating new knowledge and for stimulation of creative activity of faculty and students. Formation of research skills can be accomplished through the use of active learning methods involving conscious participation of students in the educational process. Considering the specifics of the operation of Research University, the most effective way to develop cognitive and creative abilities of students is to involve them in scientific work.

This activity should be conducted through partnerships within scientific, educational and project activities, and should result in collaborative scientific knowledge. This goal can be achieved through the development of transdisciplinary research and the motivation of students’ participation in research and project work existing and emerging at ITMO University startup accelerators, engineering centers, business incubators, FabLabs. In accordance with this roadmap a structure of Educational Environment to support knowledge transfer process has been established at ITMO University (Fig.1).

The general concept is that all of these Centers of Excellence, together with administrative departments and units function on the basis of a unified infrastructure of knowledge management. In such a way a comprehensive support of the transfer of intellectual capital is provided.
Core specialization of eScience Research Institute is to provide methodological, technological and infrastructure support in the framework of the Center of Excellence of Information Technologies for Economics, Sociology and Arts.

**Computational Science & HPC in Russia**

Day to day running of a modern society produces much data. Intelligent processing of these data with HPC methods helps research to solve complex problems in computational finance, biology, medicine, physics, astrophysics or chemistry. Therefore the tasks of education of specialists in HPC become more and more relevant.

Propagation of programs in Computational Science is of high priority in state-funded educational institutions and is supported within various projects of the Russian Government. The first attempts to stimulate Supercomputer Education were undertaken in 2010 http://hpc.msu.ru/?q=node/117. More than 40 Russian universities participated in this project and more than 100 courses were designed for Bachelor and Master Programs. It boosted a quick growth of the number of engineers and researchers in Computational Science. In this project ITMO University played a flagship role in the design of international educational programs primarily thanks to our new Double-Degree Master Program in Computational Science.

Launched in 2012 Double Degree Master Program in Computational Science “Supercomputer Technologies in Interdisciplinary Research” is based on successful R&D projects and is a one-of-a-kind in the field of Engineering Sciences in Russia both in content and form.

Due to the nature of Computational Science which consists of modeling, simulation and analysis of complex systems, it can be applied to various spheres of human life. The corresponding educational programs should embrace both highly specialized and applied aspects of the use of Supercomputers in science, education and industry.

We presume that these types of programs could be best implemented at the graduate level of study due to high levels of competencies, advanced analytical skills, and the firm theoretical basis of the students.

**Prerequisites to new curricula design**

After the implementation of the Bologna Reform in the Russian Federation, which began in 1991, Russian engineering education and higher education as a whole underwent several iterations of educational (learning) standards. In general, the drastic change caused by the implementation of the Bologna reform in Russia is a transition from the 5-year cycle (the so called “specialist” degree) to 4 years for a bachelor degree and 2 years for a master’s degree. This concept was adopted without enthusiasm by the community of educators of the post-Soviet area. The first attempts in designing the bachelor and master curricula consisted of simple division of the ‘specialist’ curriculum from 5 years to 4 and 2 years respectively.

Partly due to a certain resistance by advocates of a 5-year ‘specialist’ curriculum, the Federal State Standard of Higher Education was edited several times. At the moment all Russian higher education establishments deliver educational services under the Federal State Standards of Higher Education of the third generation [12]. Accordingly all master programs are reformed in Russia through the exchange of students, and the teachers, cooperation with universities and high-tech companies around the world through the systemic activation of cooperation with universities and high-tech companies around the world through the exchange of students, and the teachers, the development of academic mobility, the implementation of joint educational programs, and the introduction of new teaching methods (including distance learning and individual learning trajectories).

Proactivity of ITMO University to ensure both its own competitiveness in the educational market in Russia, as well as abroad, and professional competitiveness of its graduates, the proactivity of ITMO University stimulates a range of measures to ensure the integration of social, humanitarian, and professional components of the educational process that meet the requirements of the knowledge-based economy and the Bologna Process.

This is achieved the formation of students’ ideas about sustainable unity of science and education and common manifestation of the laws of creativity in the realization of scientific truths and in the development of humanitarian values and creative qualities as unique combination of motivational, intellectual, aesthetic, and communicative parameters.

Furthermore, it requires modernization of the existing curricula of undergraduate and graduate programs with a focus on research and project activities in the areas of expertise of Centers of Excellences of ITMO University.

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the degree received and appendices that could be issued in a foreign language. Nevertheless the standards approved by the ITMO University Academic Council preserve the state status.

The autonomy that comes with National Research University status grants us the possibility to build more flexible curricula. In the framework of the “5/100/2020” program, to improve competitive advantages internationally, ITMO University has developed a number of regulatory documents. One such document is the Concept of Social and Humanitarian Development, which aims at the formation of a wide range of competencies of the students. It is a well-known fact that principle university rankings and European and US program accreditations consider the employment rate of the graduates and salary of alumni to be one of the key criteria.

In following the course of the program to improve international competitiveness, ITMO University relies on diversification of scientific and educational activities within traditional "engineering" areas of excellence (nanotechnology, photonic and laser technologies, ICT, etc.). The Centers of Excellence act as a basis for the formation of personal competencies of graduates in STEM as well as in Natural sciences. The source of differentiation could be found in neighboring areas (recipients of core competencies, for example, “ICT in biology and medicine”, “ICT in life sciences”), and the social and humanitarian components of an educational process focused on the formation of the creativity of the graduates.

Development of Hybrid (Multidisciplinary and Transdisciplinary) programs

The demand for educational services in engineering as compared to the humanities is inversely proportional to the level of economic development of the country. As a consequence, Engineering universities in developed countries have either to develop new markets (e.g., developing countries or BRIC) or offer the existing markets a new field of study, including a shift towards Social Sciences and Humanities. This is reflected in the creation of hybrid (interdisciplinary [13], [14] and transdisciplinary [15]) trends of education aimed at preparing graduates to meet the requirements of a knowledge-based economy.

The aim of such programs is to provide graduates with:

- basic competencies for interdisciplinary (or multidisciplinary) scientific knowledge acquisition, as well as outlook and creativity in general (e.g., Philosophy of Science);
- professional competencies (e.g., Project Management);
- collaborative competence in their professional field, including international teams (group work, academic (scientific) writing);
- socialization of graduates in terms of knowledge economy, for example, when moving to another country, remote work, networking, etc.;
- intrinsic motivation, including self-identification (e.g., time management).

Hybrid programs can be built on different principles, e.g. programs at the junction of research and areas with the subordination of one area to another. One example is Mathematical Methods in Economics, symbiotic program with the new knowledge at the intersection of the existing approaches (Social Computing, Social-inspiring ICT), as well as a proper transdisciplinary program.

Transdisciplinary programs are based on the methodological core (basically, these are diffuse technologies like ICT or mathematical modeling) used to study global real-world systems (GSS, Global System Science), incorporating (as all real-world systems) extensive social and humanitarian components.

These global systems include contemporary cities (viewed as a whole), global trade and financial systems, transportation systems, manufacturing and distribution of resources, etc. The advantage of transdisciplinary educational programs in comparison to multidisciplinary programs is their nonclosed nature (i.e. apart from obligatory core courses, there is a set of subject-matter courses that can be changed) which provides the ability to schedule and vary individual educational trajectories for the students of different directions (specialisations) - both with a focus on STEM and Humanities.

Embodiments of such transdisciplinary programs are, for example:

- Master's program “Management of spatial development of cities” implemented by the Higher School of Economics (HSE), Moscow, Russian Federation (a typical example of a transdisciplinary course “Theory of the spatial organization of the city and the formation of the urban environment”) [16]

- The Urban Studies Program, Brown University, USA (typical course “The City, the River, and the Sea: Social and Environmental Change at the Water's Edge” [17] and “Food and Society: Exploring Eating Behaviors in Social, Environmental, and Policy Context” [18])

Having analyzed the best foreign practices, we realized the need to create similar Master's programs in our department and invite EU lecturers to deliver some of the course material.

INTERNATIONAL CURRICULA IN COMPUTATIONAL SCIENCE AND HPC

The central mechanism of the transformation social and humanitarian component in ITMO University is creation and promotion of transdisciplinary areas of training a new generation of graduates - professionals, positioned at the junction of the traditional areas of excellence at ITMO University and social and humanitarian areas, with a focus on the future needs of the job market. So the list of courses for the Master's programs in Computational Science and HPC are
based on desirable exit qualifications (competencies) - general (hard Skills), socio-personal (Soft Skills), and professional (specialized in a particular area).

All master programs are developed and delivered in English and in accordance with the European Credit Transfer and Accumulation System (ECTS) to provide international comparability of educational programs, to facilitate mobility and academic recognition. All three programs last two years and contain courses and activities of 120 ECTS.

**Double Degree Master’s program in Computational Science**

Double Degree Master's program in Computational Science “Computational Science in Multidisciplinary Research” in compliance with ITMO University standard in Applied mathematics and informatics in collaboration with the University of Amsterdam, The Netherlands implements the following principles:

Figure 2 shows schematically the structure of the curriculum of Double Degree Master's program developed in 2012 in accordance with the requirements of the federal state educational standards of higher education of the third generation. The main distinctive feature of the educational standard of the third generation is the fact that special attention is given to the development of competencies of different levels, but not predominantly knowledge and skills.

Students, who manage to get all 120 credits and defend their Master thesis, obtain two Master’s degrees both from UvA and ITMO University. The two prerequisites to enter this program and other two programs of the HPC department are as follows: (1) Bachelor's degree in STEM or equivalent, completed with good grades; and (2) Sufficient proficiency in the English language.

The list of Double Degree Master's programs in Computational Science courses is based on three levels of desirable exit qualifications students need to develop - hard skills, soft skills and professional competencies in some specialized fields like Scientific Visualization, Geoinformatics, and Computational Finance.

60 ECTS forming general scientific and professional competencies are allocated to the basic part of obligatory general and professional courses (37 ECTS). 20 ECTS are for variable parts (elective courses) of general and professional courses, and 3 ECTS are for the final state examination.

Accordingly, Research Work (45 ECTS), consists of R&D work under the supervision of a professor from ITMO University or UvA, literature study, seminars, and project activities (15 ECTS), which includes individual and group research projects resulting in a presentation before a committee consisting of academics and business representatives in the framework of internship, obligatory English language course (3 ECTS), and extracurricular courses (e.g. “Academic English”, “Scientific Writing in the English Language”), which constitute the second half of academic load of this program.

Our practice in the framework of this program has shown that the majority of Russian STEM students have difficulties with the English language. For some engineering students, in fact, an act of communication - even in their native Russian language causes difficulties. Therefore, the second half of this program aims to develop social and personal competencies (soft skills) through individual projects, internship in IT companies in the 3rd semester, and team-based learning.

**New Master’s Programs in Computational Science**

After the successful launch of the Double Degree Master's Program in Computational Science “Computational Science in Multidisciplinary Research” together with the University of Amsterdam, The Netherlands, the HPC department of ITMO University strongly considered the demand for applied transdisciplinary graduate programs. Curriculum of Master's Program in Urban Supercomputing was created. It comprises
three individual trajectories and is built on the principle of the Concept of Social and Humanitarian Development of ITMO University.

Fig. 4. Curriculum of Master's program in Urban Supercomputing.

During the first and second semesters, there are mainly Obligatory General courses. Masters of all three specializations take courses separately. In total 8 core courses and 7 elective courses are required to obtain one of three offered specializations:

- Social Urbanistics,
- Computational Urbanistics,
- Big Data in Urbanistics.

In the third semester the specializations start to meet within this or that course. This is a unique opportunity to set group transdisciplinary tasks for students. This practice will allow students to communicate on professional terms with the students of different specializations. Acquired skills might be applied while working on their graduation research projects and help them to adapt better to their future work.

Research Areas and Topics of Master Theses

The major research areas of the eScience Research Institute cover two fields that determine the content of Master students’ research works: (1) design and development of complex software for High Performance Computing and eScience infrastructures and (2) solving applied tasks and problems with the use of specialized software applications. Primarily scientific works are oriented on data assimilation, processing (including Big Data) and decision making support in critical situations. Students are involved in running research projects [16], [17], [7] together with their scientific advisers.

Below we give some examples of the students’ works with the results worthy to be published in peer review journals with a short description as well as the works that are not yet that successful.

A Technology for Big Data Analysis Task Description Using Domain-Specific Languages

This work is devoted to a technology the for dynamic knowledge-based building of domain-specific languages (DSL) to describe data-intensive scientific discovery tasks using Big Data technology [18]. The proposed technology supports the high level abstract definition of the analytical and simulation parts of the task as well as integration into the composite scientific solutions. Automatic translation of the abstract task definition enables seamless integration of various data sources within a single solution.

Personal decision support mobile service for extreme situations

Modern mobile phones and tablets are multi-purpose devices that provide their owner with rich interaction with the real world, including voice, internet, positioning technology and local interaction [19]. With the aggregate of cloud customization tools for modern mobile devices, comes the opportunity to organize massive mobile services (MMS), focused on personal decision support in a variety of situations (e.g., different types of navigators and organizers). One of the most promising areas of application of MMS is the support of mobile users in extreme (including emergency) situations. It provides information and intellectual support to users in potentially dangerous areas, in order to preserve their lives, health and property. This includes notifications about emergency situations and evacuation (i.e., evacuation from dangerous places to safe zones). Existing methods of informing and notifying the population are extensive and do not take into account the individual characteristics and location of individuals. As a consequence, it raises numerous violations of evacuation rules, such as the interruption of the chain of information or the failure to follow official regulations. In contrast, the adoption of mobile technologies focused on personal decision support allows not only an increase in the speed of response to potential danger, but to independently take measures to reduce personal risk.

The main features of the research and development of modern MMS for personal decision support in emergency situations are their dynamics and interactivity. The results of the MMS computations are not static instructions, but a set of scenarios weighted according to the degree of danger, allowing the user to make their decision on the spot.

Design of Virtual Learning Labs for Courses in Computational Science with the Use of Cloud Computing Technologies

The rise of eLearning technologies requires new forms and approaches to the design and creation of digital educational resources (DER), including virtual learning labs (VLL) to carry out scientific experiments using one or more pieces of expensive elaborate equipment and software in the remote access mode [20]. In other words, the VLL can be considered a supporting remote access distributed hard-software complex which can simulate any objects and processes. Usually these products contain application software for numerical simulation of different processes, data sources, results interpretation and visualization tools, unique and expensive equipment, and other
instruments to perform various applied tasks. Cloud computing technologies can be considered as a perspective approach for preparing DER. This work is devoted to the design and implementation of a virtual learning laboratory (VLL) with the use of cloud computing technologies within the model of AaaS (Application as a Service).

Evaluation of In-vehicle Decision Support System for Emergency Evacuation

A growing threat of natural and technical disasters in big cities, which puts more people at risk [21]. The main problem with large-scale emergency evacuations is that the population grows faster than infrastructure (including road capacity). Potential evacuation becomes more difficult and mitigation strategies should be studied. Emergency management planning is performed by special agencies, but the role of road services (including information) is growing. As a rule, transportation research on emergency situations is focused on better coordination between different agencies in relation to large-scale evacuations. The main issues are avoiding congestion collapse on the routes with limited capacity and providing centralized management. This work is about developing a simulation methodology for the evaluation of in-vehicle decision support systems for emergency evacuation based on transport systems and human decision-making modeling.

Other examples of the research of the students of Double Degree Master's program in Computational Science:

- Real-time estimation of workflow execution time in cloud computing environment,
- Genetic algorithms in MHD modelling of relativistic jets from the depths of massive black holes,
- Study of the news spread among social network users with respect to their stakeholdership,
- Finding vulnerabilities of criminal systems with the use of complex network modelling.

Master's Program Implementation

The first admission to the Double Degree Master's program in Computational Science was launched in the summer of 2012. During 2012 and 2013 University ITMO has enrolled 33 students from more than 10 regions of Russia, Kazakhstan and China. During the first year (60 ECTS) students study at ITMO University and the second year (60 ECTS) could be divided between ITMO and UvA. Students choose where to conduct research for their Master’s research project during the fourth semester since the leader of UvA Computational Science R&D group Peter Sloot holds the position of Head of Advanced Computing Lab (ACL) at ITMO University.

Starting 2013 a lot of attention was given to various aspects of the English language: (extracurricular courses) “Academic English”, “Scientific Writing in the English Language”, etc. These courses were built to include cultural study of the language to prepare the students to face the English-speaking community and academic environment.

The first course is meant to broaden their horizon in educational processes in European universities and expand their vocabulary with new terms they might need during the learning process abroad. The second course is oriented to disseminate their scientific work in English in the format of a scientific paper.

In the first intake of 2012 four students managed to score sufficiently high grades in the TOEFL test and were admitted to UvA for their second year. They have completed successfully the courses they selected in UvA with the grades of 8.0 and 8.5 (out of 10). All the other students received only one degree, from ITMO University. Others students had to continue their studies (in the third semester) at ITMO University. Each student selected four out of the first six courses of the third semester and passed the corresponding tests.

The students from the first batch of Double Degree Master's program in Computational Science in 2012 defended their Master’s theses in the English language on July 23, 2014 in front of the Committee consisting of ITMO and UvA professors. The option to submit a master thesis in the English language without a Russian version is a unique practice in Russian education.

In general we assume that the recognition of masters programs is evaluated according to several criteria:

- Program Organization and Administration (ITMO University is state accredited institution of higher education and UvA status is provided by The Accreditation Organization of the Netherlands and Flanders (NVAO) and UvA is 83 in the world university rankings 2012-2013 by Times Higher Education);
- Program Resources (facilities of eScience Research Institute and ACL Lab in Russia and Science Faculty of the University of Amsterdam in the Informatics Institute in the Netherlands);
- Student Admission (competition of the level of applications to the program and high entry requirements);
- Progression and Graduation Requirements (60 ECTS in ITMO University and 60 ECTS in UvA, preparation and acceptance of a well written document (thesis));
- Curriculum (corresponding to the standards of both partner universities);
- Program Evaluation.

About 70 % of UvA graduates follow the academic career and get a Ph.D. position in leading EU universities, the rest of the masters in CS proceed with professional careers and in most cases pick up jobs at the companies they used to train during summer internships. Apart from the usual alumni records we are planning to conduct a survey in autumn 2014 to keep track of the progress of our graduates. The survey will cover such aspects as employment status in academic or professional path, salary range, application of research, and professional and communicative skills in their work. We are also interested how Double Degree graduates evaluate the ITMO and UvA experience, whether they are networking with
peer students and professors of both universities, and whether their expectations of the Double Degree experience were met. It may take a minimum of 5 years of monitoring the alumni status to get a clear picture of what the synergy of Russian and Dutch universities brings to the students apart from the international experience and programming and research skills.

CONCLUSIONS AND FUTURE WORK
We’ve introduced the curricula for a new generation of graduates in Russia who are able to quickly and efficiently adapt to changes in science, technology, and economy. The formation of such an environment is based on the modernization of existing structures of ITMO University to form a pool of interdisciplinary and transdisciplinary directions (both for educational and scientific activities) corresponding to the realities of the knowledge-based economy. This activity entails a change in the traditional approach to t collective (teachers’ and students’) scientific knowledge acquisition in educational process, research, project and innovation activities.

A lot of work being done, there is still a lot of work to be done in the future to comply with ever changing reality and competition. The goals we set for our master program to become internationally recognizable and our graduates to stand out from the crowd in the IT job market worldwide are rather ambitious. It is important to put a great deal of effort in the fight for the best applicants, e.g. introduction in the future of TOEFL partnership with UvA.

Institute for Advanced Study in the Humanities and Social Sciences’ colleagues and foreign scientists and experts in the teaching process will contribute to the formation of professional competencies for our students. Moreover, at this level of program development it is important to put a great deal of effort in the fight for the best applicants, e.g. introduction in the future of TOEFL and/or GMAT as enrollment requirements in ITMO University, Russia.

We described a first joined attempt of ITMO University and UvA to increase the competitiveness of engineering education in Russia by raising graduates who possess the skills and abilities from various domains and capable to use those skills to address specific tasks of real life. To highlight that Big Data is applied not only in Urbanicities, in pursuit of the latest trends in 2014 we developed one more Double Degree Master’s Program in Big Data and Extreme Computing in partnership with UvA.

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