Development of Soft Skills by Doctoral Students

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Abstract. This paper has been prepared as a part of the capacity building project "Modernization of Doctoral Education in Science and Improvement of Teaching Methodologies" made possible by the programs of Erasmus+. The main aim of this project is to improve the quality of doctoral education by implementing new teaching methodologies based on interdisciplinary approaches and international cooperation. The author presents Russian system of Doctoral education, its structure, content and main competences required for training highly qualified researchers. The paper focuses on developing communicative skills by PhD students in the framework of Foreign Language Course which is included Doctoral degree programs.

Keywords: Doctoral degree programs · Soft skills

1 Introduction

The Russian higher education system consists of three levels: undergraduate studies (Bachelor's degree (4 years) or Specialist's degree (5–6 years)), graduate studies (Master's degree (2 years)), and post-graduate studies (doctoral education). This system follows the principles of the Bologna process and its development and implementation began in 2013.

The structure and context of all doctoral degree programs are run in accordance with the Federal State Educational Standards, where the expected educational outcomes are listed and characterized by the following competencies: universal, general professional and professional competencies. General professional and professional competences are developed in accordance with the direction of each doctoral degree program and include specific professional and research skills. As a rule, the universal competences are similar for all doctoral degree disciplines and include skills such as critical thinking and evaluation of contemporary scientific achievements; conducting research in interdisciplinary fields; participating as part of Russian and international research teams; being able to communicate in the academic sphere in Russian and other foreign languages; as well as self-directed professional and personal development. These competences aim to develop and foster doctoral students' soft skills, which have recently become important components for being a competitive candidate in the field of research and education. However, one of the issues with the Russian higher education

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system is implementing new content and teaching methods, which would lead to effective hard and soft skills development in doctoral degree programs.

2 Structure and Content of Doctoral Degree Programs

Traditionally, doctoral education in Russia has focused on training doctoral students to be ready for conducting research in one specialized field of science [1]. In the past, doctoral students were required to pass candidate exams on Foreign Language, Philosophy, and a specialized subject related to the field of their research. After, Ph.D. students had the opportunity to defend their doctoral thesis and obtain a PhD degree. These students possessed specialized hard skills related to the field of industry or science but were unable to apply these skills across other disciplines.

As a solution, new Federal State Educational Standards were developed, which specified the expected outcomes, content, and structure of doctoral education.

Doctoral education is also called "highest professional training" and aims at training "professionals of the highest qualification". According to the "Law on Education in the Russian Federation", there are over 50 disciplines in which a student can pursue doctoral study, 29 of them are developed for STEM disciplines. The list of these "directions" is given in Table 1.

Table 1. Russian doctoral program directions

Code	Doctoral program direction
Mathematical and Natural Sciences	
01.06.01	Mathematics and Mechanics
02.06.01	Computer-Based and Information Science
03.06.01	Physics and Astronomy
04.06.01	Chemical Science
05.06.01	Earth Science
06.06.01	Biological Science
Engineering, Technological and Industrial Sciences	
07.06.01	Architecture
08.06.01	Civil and Industrial Engineering
09.06.01	Informatics and Computer Science
10.06.01	IT Security
11.06.01	Electronic, Radio, and Communication Systems
12.06.01	Photonic, Instrument-Making, Optical, Bioengineering Systems, and Technologies
13.06.01	Electrical and Heat Engineering
14.06.01	Nuclear, Thermal, Renewable Energy, and Related Technologies
15.06.01	Mechanical Engineering
16.06.01	Physical and Technical Sciences and Technologies
18.06.01	Chemical Technology

(*continued*)

Table 1. (*continued*)

Code	Doctoral program direction
19.06.01	Industrial Ecology and Biotechnology
20.06.01	Technosphere Safety
21.06.01	Geology, Exploration and Development of Mineral Resources
21.06.02	Geodesics
22.06.01	Materials Science and Technologies
23.06.01	Engineering and Technologies of Ground Transport
24.06.01	Aeronautics and Space Equipment
25.06.01	Aircraft Navigation and Operation
26.06.01	Engineering and Technologies of Ship-Building and Water Transport
27.06.01	Control of Engineering Systems
28.06.01	Nanotechnologies and Nanomaterials
29.06.01	Technologies of Textile Industry

Every "direction" includes several "sub-directions", or "profiles". For example, direction 04.06.01 Chemical Science includes a number of profiles:

- Crystallography, Physics of Crystals
- Inorganic Chemistry
- Analytical Chemistry
- Organic Chemistry
- Physical Chemistry
- Electrochemistry
- High Molecular Weight Compounds
- Chemistry of Element Organic Compounds
- Chemistry of High Energies
- Bioorganic Chemistry
- Colloidal Chemistry
- Petroleum Chemistry
- Radio Chemistry
- Kinetics and Catalysis
- Medical Chemistry
- Mathematical and Quantum Chemistry
- Chemistry of Solid Body
- Ecology

As a rule, a university runs several doctoral programs, e.g. Kazan National Research Technological University (KNRTU) runs doctoral programs in 16 directions, including 44 profiles. In Chemical Science, the university runs 8 profiles, including Inorganic Chemistry, Analytical Chemistry, Organic Chemistry, Physical Chemistry, High Molecular Weight Compounds, Colloidal Chemistry, Petroleum Chemistry, Kinetics and Catalysis.

Every direction of doctoral studies is implemented in accordance with the Federal State Educational Standard which includes a set of requirements regarding the contents

of the program, the number of credits, the period of study, the professional areas for the graduates, the program outcomes, outputs and impact, the program structure, and the conditions under which the program can be run.

The period of study in most STEM programs is 4 years, including 60 credit units per year. One credit equals 36 academic hours, an academic hour is 45 min. There are two forms of study: full-time (intramural) and part-time (extramural).

Intramural studies imply a two-semester academic year with two examination sessions in winter and in summer, and two breaks: a short winter break (mid-January – mid-February) and a long summer break (July – August). During the semester, doctoral students have to attend classes, work in the laboratory or in the library every day. Intramural studies last 4 years.

Extramural studies can last 4.5–5 years. In this case, doctoral students do not have to attend classes during the semesters, but they have to self-study and are still required to take exams during every examination session. The university is free to develop its own form of extramural studies.

Doctoral program outcomes and outputs are evaluated in accordance with the competencies developed by the graduates. The competencies are subdivided into:

– universal competencies;
– general professional competencies;
– professional competencies.

Universal competencies are given in Federal State Educational Standards and are similar for all doctoral programs, general professional competencies are also given in the Standards for every "direction" of doctoral education, while professional competencies are developed within the university for every "profile" of doctoral education.

For example, looking at the direction 'Chemical Sciences' and the profile 'Colloidal Chemistry' at the university:

Universal competencies include:

- critical thinking and evaluation of contemporary scientific achievements, generating new techniques and experiments to effectively generate new research in order to solve applied problems in interdisciplinary fields;
- design and complex research including interdisciplinary research based on the integral system view using principles of history and philosophy of science;
- participation in Russian and international research teams to address research and educational problems;
- application of contemporary methods and technologies to be proficient in academic communication in Russian and foreign languages;
- self-directed professional and personal development.

General professional competencies include capabilities of:

- self-directed independent research in corresponding professional areas using modern methods, information, and communication technologies;
- leading a research team in chemistry and complementary sciences;
- teaching chemistry in undergraduate and graduate degree programs.

Professional competences formulated at KNRTU for Colloidal Chemistry profile include capabilities of:

- written and oral professional communication of ideas, problems, and their solutions in a logical and well-structured manner using appropriate terminology in the English language;
- appropriate choice of software for research and teaching;
- application of basic theory and ideas of colloidal chemistry in professional activities, mathematical analysis, theoretical and empirical research methods;
- doing physics and chemistry related experiments, processing their results, evaluating the margin of error, modeling physical and chemical processes and phenomena, setting a hypothesis and boundaries of its application;
- applying theory and methodology of physical and chemical research in studying different types of matter organization, including synthesis and analysis of liquid crystals and nanomaterials;
- using fundamental and applied knowledge principles in colloidal chemistry;
- making technical decisions in developing chemical engineering processes and choosing technologies considering their potential environmental impact;
- utilizing the results of research in colloidal chemistry for solving applied problems;
- organizing and leading research groups in colloidal chemistry, directing research seminars, and supervising student research;
- self-directed independent research in colloidal chemistry satisfying doctoral degree requirements;
- following ethical regulations in professional activities;
- organizing professional teaching based on theory, methodology, and technologies of educational science;
- planning projects, evaluating resources, and administering teams in professional settings.

Table 2 gives examples of study plans for direction “Chemical Science”, profiles “Physical Chemistry” and “Colloidal Chemistry”.

During the first year of studies, students in all doctoral programs attend three academic courses:

1. Foreign Language;
2. History and Philosophy of Science;
3. Computer Technologies for Science and Education.

For the first two courses, doctoral students take exams at the end of the first year of studies. The grades for these exams are included into the student’s CV, announced during the viva (defense procedure) and are sent in the package of documents to the Highest Attestation Commission if the doctoral student decides to defend his thesis. The third course is ungraded. Apart from these academic courses, the students start their research under supervision of the principal investigator.

During the second year of studies, students take 7 academic courses and take an exam in their “profile” course. Apart from these courses, students continue their research and have practice in teaching undergraduate students called teaching internship.

The third year of studies is dedicated solely to research.

The fourth year of studies includes research practice, finalization of research experiments, and final state exams.

Extramural programs last 5 years. The structure is similar to intramural programs with an additional year given for research.

Upon the completion of any doctoral program, a doctoral student has to pass the final state exam and give a report presenting the outputs, outcomes, and impact of his research to a board of professors for approval. Upon successful completion of the final exam and report, the doctoral student is conferred a new qualification attested by a state document. Depending on the doctoral program curriculum, there are two options for the qualification, either "Researcher" or "Educator and Researcher". Apart from this qualification, upon completion of the doctoral studies program, a doctoral student is given permission to defend his doctoral thesis.

Table 2. Study plans for direction "Chemical Science", profiles "Physical Chemistry" and "Colloid Chemistry"

Direction 04.06.01 "Chemical Science"	
Mandatory courses (9 credit units)	
Foreign Language	
History and Philosophy of Science	
Optional courses (21 credit units)	
Profile "Physical Chemistry"	Profile "Colloidal Chemistry"
Computer Technologies for Science and Education	Computer Technologies for Science and Education
Commercialization of Research Results. Principles of Fundraising	Commercialization of Research Results. Principles of Fundraising
Physical Chemistry	Colloid Chemistry
Physical Chemistry of Supramolecular Systems	Current Issues in Chemistry
Theoretical and Experimental Research in Chemistry	Surface Chemistry, Adsorption, and Nanosystems
Physical and Chemical Processes for Chemical Technologies	Colloid Chemistry of Surfactants
Methodology, Theory and Technologies of Professional Education	Methodology, Theory and Technologies of Professional Education
Psychological and Pedagogical Science for Personal Self-Development	Psychological and Pedagogical Science for Personal Self-Development
Internship and Research (201 credit units)	
Teaching internship (practice in teaching students)	
Research internship (practice in professional area)	
Research project	
Preparation of doctoral thesis	
Final State Exams (9 credit units)	
Preparation to successfully pass final state exams and presenting a scientific report	

However, the traditional system of doctoral education slows the development of the new principles of doctoral education aimed at fostering the soft skills of doctoral students. Therefore, it is of great interest to solve this problem by analyzing European educational systems and applying effective practices in doctoral programs at our university.

3 Developing Soft Skills by Doctoral Students Within the Framework of Foreign Language Course

Different international and Russian literature data on developing the soft skills of doctoral students in European universities were collected and analyzed [2–7]. There were different meetings with EU and UK representatives who are responsible for doctoral degree programs at their universities. According to these meetings and analyses three main categories of competences related to soft skills were selected:

- personal skills;
- communicative skills;
- career management skills.

Developing these skills is the most important for doctoral students conducting their research in chemical, physical or engineering sciences.

One of the most important communicative skills for European doctoral students is academic communication and writing in the English language. The English Language as a course of doctoral education curriculum was specifically created to implement the principles of soft skills training for doctoral students. It includes scientific communications, writing scientific articles and abstracts, preparing conference presentations, preparing documents for applying for international grants, working in an interdisciplinary environment and international teams.

Doctoral students conducting research in the field of colloid and physical chemistry were chosen as an experimental group. The interdisciplinary approach was used to combine English language knowledge and chemical sciences.

The key outcome of the study is new content of a Foreign Language course specially created for developing the soft skills of doctoral students conducting research in the field of chemistry and chemical technologies. The course content was based on the interdisciplinary approach which resulted in the interaction of English knowledge with research projects of doctoral students.

Some of the English teaching materials for doctoral students were created with the help of the American assistant who worked in the Department of Foreign Languages which was made possible through the Fulbright Foreign Language Teaching Assistant Program. Such cooperation allows us to prepare authentic English exercises for developing academic writing and communication skills which meet the requirements of modern academic society. Also the active work for creating teaching materials is conducted for French and German courses [8].

The interdisciplinary approach was used to combine English language knowledge with doctoral student research. The topics and vocabulary of English teaching materials were created in cooperation with the research supervisors of the doctoral students from

the Department of Physical and Colloid Chemistry. Professors with PhD in engineering and chemistry are involved in teaching doctoral students [9]. This resulted in fostering teaching materials and educational process for professionally-focused foreign language.

Two credit hours are given for Foreign Language Course which consists of three components (modules):

- Professionally-focused foreign language.
- Academic writing.
- Presentation skills in foreign language.

The first component is designed to train Doctoral students in their special fields according to their direction. In terms of Chemical Science direction foreign language teaching materials contain grammar and stylistics for scientific chemical texts, as well as vocabulary and terms in the field of research methods for chemical parameters, processes, technologies and equipment.

The second components trains students to write scientific papers and abstracts in accordance with the requirements of international top-rated journals. Doctoral students are introduced to the structure of experimental scientific papers, and the content of each part of the papers starting from paper title to references. Students prepare their scientific papers and abstracts using the examples of materials which have been already published in top rated international journals [10].

The third component is developed to train Doctoral students to present their scientific report according to the existing well-known practices and international standards for presentations.

Such module approach has been widely used for developing structure and context of Master's and Bachelor's degree programs at KNRTU [11, 12].

The on-line study mode was developed on the basis of learning platform Moodle for part-time (extramural) doctoral students. This mode allows us to foster independent study of a foreign language by students [13].

Nowadays, there is a great number of international students from different countries who are getting doctoral degrees at KNRTU. One of the most important tasks is to create friendly and positive atmosphere for them [14]. The English Language Course has special teaching modules focused on easy and fast introduction of foreign students to the academic environment of the university.

The skills of academic writing, presentation and professional communication allow doctoral students to publish their research results in international scientific journals, present themselves and their research at international conferences, and successfully participate in international grant programs. Therefore, the Course of Foreign Language can be the starting point for creating and implementing new content of Doctoral degree programs aimed at developing communicative soft skills.

4 Conclusion

The Russian higher education system has changed significantly due to internationalization and globalization. Successful development of the Russian economy is impossible without highly qualified academic specialists who are able to conduct research on

the international level. Doctoral study as the third level of the Russian higher education system plays a very important role in training future academic employees. Therefore, developing and implementing new content and advanced teaching methods in doctoral courses are one of the most important issues concerning the higher education system. Nowadays, it is not enough to develop hard skills, which focus on scientific research, it is also important to develop soft skills such as academic communication and writing, career management, creative thinking, and working as part of a team. The combination of hard and soft skills allows graduates to find their place in the multilingual and multiethnic world of science and education.

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