The Role of Human Capital in Science, Technology and Innovation

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Abstract

As a result of the transformation of the labor market, the constant development of human capital has become crucial. This paper considers the role of human capital in professional development through the prism of 16 semi-structured interviews with both Russian and foreign graduates of a master's program focused on training experts in the field of science, technology, and innovation. Most of the graduates of the program found jobs in the corporate sector and at research centers, but among the interviewees, there were also representatives who chose self-employment or public service. The contribution of undergraduate and master's degrees to the professional development of these interviewees was assessed and they noted that if studying at the undergraduate level contributed primarily to obtaining subject knowledge, then studying at the master's level contributed to the development of missing competencies and the opening of new professional opportunities. Interviewees identified emotional and social intelligence as key skills in their professional development and noted the critical importance of digital skills and subject knowledge. In turn, the most popular way of training, in the opinion of respondents, is online education.

Keywords:
tertiary education;
science, technology and innovation (STI);
human capital

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The rapid technological development of the recent decades brings to the forefront the need to achieve the sustainable growth of the innovative knowledge-based economy [OECD, 2017]. This, in its turn, requires specific professional competences and a high level of skills [*Karnouskos,* 2017]. Workers possessing them will play a key role on the labor market, since companies' innovation development and countries' competitiveness ultimately depend on them [*Burmann et al.,* 2018].

At the same time, digitalization transforms the labor market too [*Kapeliushnikov,* 2017]. For example, there is a more than 50% probability that about a half of all jobs in OECD countries will be significantly automated, which will change skill requirements [*Nedelkoska, Quintini,* 2018]. Employers estimate that the further development of technologies and business models will make 42% of the currently applied skills totally irrelevant as early as 2022 [WEF, 2018]. Accordingly, along with the emergence of new jobs that would require unique skill sets to accomplish previously non-existent tasks, conventional jobs will also require new, unorthodox approaches [HSE, 2018].

Against the background of the digital transformation of businesses, the changing requirements for workers' competences create the need for their continuous upgrading. As a recent survey of training and upgrading professionals demonstrated, 80% of companies believed this was a priority [*Thomson et al.,* 2017]. However, volatile, uncertain, complex, and ambiguous (VUCA) business conditions make training staff on new skills which are not only relevant here and now but would also remain so in the future, a much more complex task [*Horstmeyer,* 2018]. The competence profiles that specific companies require are being constantly adapted to match the changing environment, hard-to-predict developments, increasingly complex business processes, and their interaction with each other [*Horney et al.,* 2010]. Demand for design thinking is growing, which implies a systemic approach to problems and finding solutions for them, the ability to suggest different approaches to a task, visualize and explain one's ideas, and effectively communicate with professionals specializing in different subject areas [*Razzouk, Shute,* 2012].

To increase their professional value on the rapidly changing labor market, workers need to constantly increase their human capital [NAFI, 2017] which comprises specific specialized knowledge and skills in which education plays the key role [*Biriukova et al.,* 2018]. Employers see formal qualifications as a guarantee that a worker has certain competences, which can be extended by subsequent training and retraining. This resource for developing human capital allows one to transfer the most sought-after professional skills to workers and increase their productivity [*Gimpelson et al.,* 2017].

The goal of this paper is to define the role that human capital plays in the professional development of young workers specializing in the science, technology, and innovation (STI) sphere during the first few years following the completion of their formal education. Sixteen semi-structured interviews with 2016-2018 graduates of the STI governance Master's program (ISCED 7 level) provided the empirical basis of the study. The respondents represented four career paths (tracks): most of them were employed in the corporate sector or by R&D centers, plus young entrepreneurs and civil servants. The study's methodology was based on the qualitative analysis of various components of the Global Human Capital Index developed by the World Economic Forum (WEF).

Literature Review

The term "human capital" suggested by Theodore Schultz [*Schultz,* 1961] is defined as the sum of workers' knowledge and skills that have economic value and increase productivity. Sometimes not only knowledge and skills, but natural abilities and experience are also seen as elements of human capital [*Bontis,* 1999]. Gary Becker [*Becker,* 1994] made an important contribution: he focused on education and training (upgrading) as the key factors for increasing human capital. Becker's study distinguishes between *basic training* at work over the course of which people learn skills that can be applied at other companies or in different industries, and *specific* training largely relevant for a particular company or a narrow activity area. He also suggested a model to empirically assess the economic efficiency of education as an investment in human capital.

The WEF's Global Human Capital Index provides one of the most comprehensive modern assessments of education's impact on human capital quality [WEF, 2017]. The index takes into account only skills that can be seen as a dynamic assets which develop with time, as opposed to innate abilities. The global index in question comprises four key subindices which reflect the level of human capital, its applicability and development, and the mastery of specific skills and competences [WEF, 2017]:

- *Capacity*: measures the value of formal education; the higher it is, the quicker new technologies can be adapted, and innovations applied to increase the country's global competitiveness;
- *Deployment*: is related to the application of the accumulated human capital at work, and its further increase over the course of training, professional activities, and informal exchanges of knowledge and best practices with colleagues;
- *Development*: applied to evaluate the prospects for the future development of human capital through formal education, including upgrading and retraining over the course of life-long learning;

- *Know-how*: measures the scope and level of specialized skills required for professional activities.

The OECD [OECD, 2005] identifies three key skill groups: (1) the ability to act on one's own (planning, substantiating one's position) or (2) as a member of a diverse team (teamwork, conflict management), and (3) the mastery of various tools, i.e., the ability to interactively use basic (such as reading, writing, etc.) and more advanced communication tools (information and communication technology, ICT). The international project "The Assessment and Teaching of Twenty-First Century Skills" identified four groups of such competences: those related to thinking (critical, creative), interaction (communication and collaboration), work (digital literacy), and life (responsibility, cultural awareness) [*Binkley et al.,* 2012]. Both these classifications are primarily focused on broadly understood skills required to achieve personal, social, and economic wellbeing as opposed to subject-specific knowledge which frequently cannot be applied after it was learned [*Collet et al.,* 2014]. In other words, the 21st century competences have more to do with processing information than with possessing it.

[*Pellegrino, Hilton,* 2012] break down the 21st century competences into three major clusters: cognitive, interpersonal, and personal ones. In the first group, they include digital and research skills along with critical thinking. The interpersonal skills group comprises teamwork and leadership. Personal skills include self-control, self-assessment, and an open mentality. Other well-known classifications [*Collet et al.,* 2014] seem to be quite similar to the aforementioned one. Various Russian experts also agree that the 2025 competence goal model should comprise three clusters: cognitive, socio-behavioral, and digital skills [*Butenko et al.,* 2017].

The above competency clusters comprise universal metaskills applicable in various areas [*Finch et al.,* 2013] and among those relevant for the technology and innovation sphere [*Collet et al.,* 2014]. Detailed competency lists drafted by international organizations, various research teams, or individual scientists tend to be excessively heterogenous in terms of grouping and the level of detail. Like [*Karnouskos,* 2017], we identified six major clusters, each comprising two main skill groups: research and digital skills in the cognitive competences cluster, intercultural awareness and social intelligence in the interpersonal one, and emotional intelligence and interdisciplinarity in the personal competences cluster.

Research skills traditionally play the key role in higher education. Having them, along with the ability to use them, are seen as key characteristics of university graduates, especially those at research universities [*Garg et al.*, 2018]. However, though these skills are frequently learned by taking part in research, the scope for their subsequent application is much wider than that [EuroDoc, 2018], since "research" as such is not necessarily limited to generating completely new knowledge. It also includes collecting information previously unknown to specific persons, or new in a specific context [*Willison, O'Regan,* 2007].

Basic research competences include the ability to clearly see which results should be achieved while accomplishing a specific task, the ability to find or generate new knowledge using relevant methodologies, and the ability to assess the collected information, manage it, organize, analyze, structure, discuss, and use it in the course of subsequent work [*Willison, O'Regan,* 2015]. Outside the R&D sphere, these skills can be easily transformed into others, which makes research programs' graduates highly employable (employability skills). Acquiring research competences in the course of one's education allows one to [*Bandaranaike,* 2018]:

- clearly understand one's work responsibilities and project objectives;
- identify resources and technologies required to accomplish work-related tasks;
- assess the level of one's skills and maintain it throughout one's career;
- organize one's professional activities;
- apply creative and critical approaches to problem solving;
- efficiently interact with the professional community.

The digital revolution has led to technologies' penetrating all spheres of life. As International Telecommunication Union (ITU) experts note, in effect any professional activity now requires one to have at least a basic level of digital skills [ITU, 2018], which increasingly often are seen as fundamental and universal ones (along with reading, writing, and arithmetic). However, apart from the basic level, experts identify two more levels of these skills: intermediary (ability to accomplish professional tasks such as, e.g., graphics design or digital marketing) and advanced ones (in the ICT context, this is first of all programming). As demand for digital competences grows, universities pay increasingly more attention to teaching them. For example [*Oliver, Jorre,* 2018] note that in 2015, Australian universities mentioned digital literacy skills among the results of the education they provide 14% more often. In October 2018, the pilot European survey of graduates was launched in the EU (EUROGRADUATE), in the scope of which the respondents were asked to assess how their digital skills matched employers' requirements [*Meng,* 2018].

The globalization of the labor market, along with growing professional mobility has led to the increasingly active interaction between people of various nationalities, cultures, ethnic groups, and religions, especially in global competency centers [*Huber,* 2012]. Intercultural awareness is necessary for such

interaction, which helps workers accept other people's values, traditions, and convictions – which in turn helps avoid possible misunderstandings between project participants [*Zhu,* 2011]. Such intercultural awareness elements as respect, tolerance, caring, interest in, and attention to others [*Cukier et al.,* 2015] make it possible for people to efficiently work alongside each other in the present-day multicultural, multinational environment.

Employers also have demand for such university graduates' traits as social intelligence, i.e., the ability to participate in social interaction, cooperate, establish productive social relations, build trust with colleagues, reach understanding, and share information and ideas [*Gkonou, Mercer,* 2017]. According to the classic definition by Edward Thorndike [*Thorndike,* 1920], social intelligence represents the mental ability to understand and manage relations with other people, regardless of their gender and age. An important component is effective behavior, i.e., the ability to establish relations with counterparts in various situations [*Ford, Tisak,* 1983] and "inspire others to behave effectively" as a basis for leadership [*Goleman, Boyatzis,* 2008].

The ability to be aware of one's own emotions, manage them, and move on towards a desired goal in line with one's beliefs and motivation is at the core of emotional intelligence [*Salovey, Mayer,* 1990; *Goleman,* 1995]. Though some researchers also include in this group the ability to recognize other people's emotions, unlike social intelligence, which is focused on interaction and cooperation, the emotional one is primarily about people's personal state and perceptions [*Gkonou, Mercer,* 2017]. In other words, social intelligence can be seen as an extension of the emotional one [*Goleman, Boyatzis,* 2008], though it is the latter which is frequently considered a key competence highly skilled workers are expected to have [*Mayer et al.,* 2008].

Surveys show that for employers, graduates ideally should be capable of a broad interdisciplinary vision [QS Intelligence Unit, 2017]. An interdisciplinary approach implies the ability to understand and solve problems by going beyond the concepts, techniques, and epistemological characteristics of specific disciplines, and merging them together [*Seow et al.,* 2019]. This requires being open to new ideas, curious, flexible, and inventive when applying experience gained in other professional domains to one's own [*Tait, Lyall,* 2007]. Such skills allow one to disregard conventional views and approaches in order to see one's objectives more broadly and comprehensively. As [*Oliver, Jorre,* 2018] demonstrated, if in 2011 none of the surveyed universities included interdisciplinarity into the expected results of education, in 2015, 22% of the universities did so.

Subject-specific knowledge remains extremely relevant for the technology and innovation sphere [*Collet et al.,* 2014]. Success in these areas depends not so much on creatively designing new solutions and applying them in practice, as on the ability to sell them in competition with people suggesting other approaches. Thus, future technology and innovation professionals must have all of the above six types of the 21st century skills, plus subject-specific knowledge. This mix will help one successfully apply the assets acquired over the course of education to subsequent professional activities.

Methodology of the Study

A key factor of human capital development is formal education at specialized educational organizations. One of the objectives of our study was evaluating formal education in Bachelor's and Master's programs. Baccalaureate is believed to make up the core of the education system providing a "broad" education, i.e. giving students a massive amount of basic knowledge and laying a foundation, including methodologically, for subsequent lifelong (self)learning [*Volkov et al.,* 2008]. A two-tier higher education system allows Bachelor's graduates to enter the labor market earlier, find out which specific knowledge and skills they need, and choose an appropriate Master's program. Furthermore, students can intentionally choose Bachelor's and Master's programs in different areas, combining various specialized skills and subject-specific knowledge [*Jacobs, van der Ploeg,* 2006]. Our *first hypothesis* is that the main value of a Bachelor's degree for graduates may be in creating a broad theoretical and practical base, while Master's programs provide the missing professional competences in specific areas.

Unlike the Baccalaureate, Master's programs are more specialized, designed to provide specific knowledge which (because it becomes obsolete relatively rapidly) remains outside the scope of the longer Bachelor's studies [*Volkov et al.,* 2008]. Bachelor's courses have a more general nature, while Master's programs are focused exclusively on the applied aspects of relevant disciplines [*Alessi et al.,* 2007]. The Baccalaureate can be seen as an entry point into a profession, while Master's programs and subsequent education stages can be seen as ways to acquire more precise and relevant professional skills [*Collins, Hewer,* 2014]. Our *second hypothesis* states that Master's programs train graduates to match the current changes in professional requirements, regardless of the chosen career path.

Lifelong (re)training is becoming increasingly important. According to our *third hypothesis* which takes into account the current education trends and related technologies, online courses became the most popular tool for upgrading qualifications [*Hamori,* 2018]. Acquiring relevant skills and qualifications requires constant personalized learning, which conventional upgrading programs provide only up to a point [*Egloffstein, Ifenthaler,* 2017]. And if at the early stage mass open online courses

(MOOCs) were mostly applied in the higher education context, lately the focus has shifted towards the corporate sector [*Dodson et al.,* 2015].

As MOOCs became more advanced, company personnel obtained the opportunity to develop their professional competences on their own, and at minimal costs (in effect for free), leading to increased productivity and improved general qualifications, optimizing certain work operations and becoming leaders in new areas [*Karnouskos,* 2017]. MOOCs allow one not only to find relevant materials and scale one's learning, but avoid taking on any additional obligations. This flexible personification of training depending on the trainees' needs makes MOOCs an extremely attractive tool for upgrading one's qualifications [*Park et al.,* 2015].

As [*Egloffstein, Ifenthaler,* 2017] demonstrated, MOOC students working for companies operating in various sectors of the economy see their professional development as the key objective. In other words, work- or career-related goals prevail over personal interests, though the respondents do not expect to be rewarded by their employer. On their part, companies also use this staff training and upgrading format increasingly often [*Karnouskos,* 2017]. MOOCs can help advance specific skills, or serve as prerequisites for subsequent in-depth corporate training which allows one to cut relevant costs [*Dodson et al.,* 2015]. Corporate online courses (only available to the organization's personnel) are also being designed and offered [*Egloffstein, Ifenthaler,* 2017].

The OECD experts identified six groups of most sought-after professional skills relevant for the innovation sphere: digital literacy, research abilities, subject-specific knowledge in relevant areas, general competences (e.g. critical thinking), soft skills (communication, teamwork), and leadership [OECD, 2011]. Skills most frequently mentioned in the literature include communication, interaction, and establishing social relations [*Lexen, Bejerholm,* 2016]. A recent study revealed that emotional intelligence of project team members has turned into an extremely important innovation activity factor [*Tsakalerou,* 2016]. According to our *fourth hypothesis*, science, technology, and innovation managers – the Master's program graduates – over the course of the last three years have found behavioral traits such as social and emotional intelligence to be particularly important [*Gutstein, Sviokla,* 2018].

We have conducted a survey of the English-language Master's program for managers of the science, technology and innovation (STI) sphere. The program is designed to teach skills such as analyzing innovation systems, designing and evaluating STI policies, and conducting foresight studies. Russian and international researchers with practical experience in international interdisciplinary studies, members of federal executive authorities, and businessmen (including start-up owners) are involved in teaching. During the training students have a chance to study at foreign partner universities, for short (in the framework of a student exchanges) or long (in the scope of dual diploma programs) periods. Since the program's launch in 2014, 104 students have graduated, of them 29 foreigners.

We adapted the Global Human Capital Index methodology [WEF, 2017] to measure human capital at the individual level. For each of the four sub-indices (capacity, deployment, development, and know-how) questions were designed to identify the relevant human capital elements (Figure 1). For example, to assess capacity, the respondents were asked to estimate the value of their education for their professional and career development. In terms of deployment, questions about the importance of education for career growth and adapting to changes at work were specifically formulated to match the Master's level. To measure the development sub-index, we asked questions about qualification upgrading mechanisms. The final element, specialized knowledge and competences (know-how) was assessed using a 10-point scale for each of the seven skill groups, followed by questions designed to explain the assigned scores and find out if there was any need to expand the list. Most of the questions were open and required an extended response, additional explanations were obtained during personal interviews with the respondents.

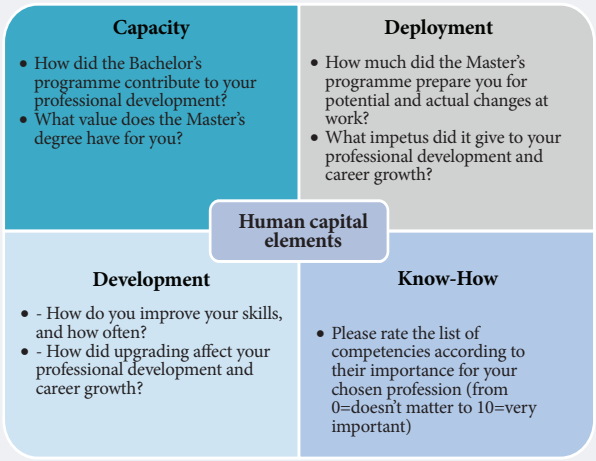
The survey was conducted using a qualitative method of semi-structured interviews. This allowed us to find out the respondents' individual opinions, perceptions, and career results taking into account the effect of specific factors in specific organizations and professions [*Hirschi et al.,* 2018]. A total of 16 Master's program graduates were interviewed, who have completed their studies in 2016-2018. The respondents were selected using a criteria-based approach [*Steinberg,* 2009] comprising two key indicators: graduation year and career path. The resulting sample (see Table 1 for the respondents' main characteristics) reflecting various career paths appears to be optimal for this kind of study. It allows one to take into account the variability of selected cases, while keeping the amount of repetitive information at a minimum [*Kvale,* 2008].

Most of the surveyed graduates represented two key career paths: the corporate sector (respondents 2-9, track CS), and R&D centers (respondents 12-16, track R&D), eight and five, respectively. Two more graduates have chosen to create their own companies (respondents 10-11, track S), and a single one opted for a career in public administration (respondent 1, track PA). Four out of the 16 respondents are foreign nationals.

Results of the Study

The first group of questions (the assessment of human capital) were related to estimating the value of

Figure 1. **Methodology**



Source: composed by the authors.

the formal education the respondents received. All of them gave it high marks, noting its role in accomplishing their personal and professional goals. Note that the respondents' perception of Bachelor's and Master's level education was quite different. Assessing their Baccalaureate, most of the respondents (11 out of 16) stressed the importance of theoretical and practical knowledge and skills that helped with their subsequent professional development (Figure 2): *"The university gave me a basic understanding of how markets work. This provided the core for accumulating further knowledge at work" (respondent 4, track CS)*. Five respondents stated that Bachelor's program not only helped them build the necessary theoretical foundation, but also promoted their personal development to become people who, as one of the graduates put it, *"always try to acquire new knowledge and experience" (respondent 3, track CS)*. Other important values included networking, extending social contacts, and developing soft skills (four mentions each).

The Master's degree was assessed as equally useful for further personal and career development (Figure 3). According to 11 respondents, it helped them acquire additional in-depth knowledge and specific competences they lacked after completing their Bachelor studies. One of the respondents noted that *"A distinctive feature of the Master's program was intensive training: the results achieved in two years' time were higher than those of the four year-long undergraduate studies" (respondent 2, track CS)*. However, this opinion seems to be an exception: in many cases the respondents assessed the value of Bachelor's and Master's education more or less equally, while describing them in totally different terms.

In terms of professional development and adapting to changes at the workplace (the second hypothesis), graduates received specific knowledge in areas such as STI governance, assessing its productivity, innovation economy mechanisms, strategic planning, and Foresight. This helped them integrate their previous experience gained in various areas and significantly expand the potential scope for professional activities.

Table 1. **The Sample of Respondents**

Respondent	Graduation year	Nationality	Type of organization	Industry	Career path (track)
1	2018	Russia	National	Public Administration and Military Security; Social Security	Public administration (PA)
2	2018	Russia	International	Management Consulting	Corporate sector (CS)
3	2018	Russia	International	Computer Software Development and Related Services	
4	2018	Russia	International	Information Technology	
5	2018	Russia	International	Information Technology	
6	2017	Russia	International	Management Consulting	
7	2017	Russia	International	Management Consulting	
8	2016	UK	International	Finance and Insurance	
9	2016	Russia	International	Telecommunications	
10	2018	Brazil	National	Information Technology	Start-ups (S)
11	2017	Russia	National	Administrative and Related Services	
12	2016	Turkey	International	Education	R&D
13	2016	Russia	International	Education	
14	2016	Russia	International	Education	
15	2017	Russia	International	Activities of Extraterritorial Organizations and Bodies	
16	2017	Romania	International	Education	

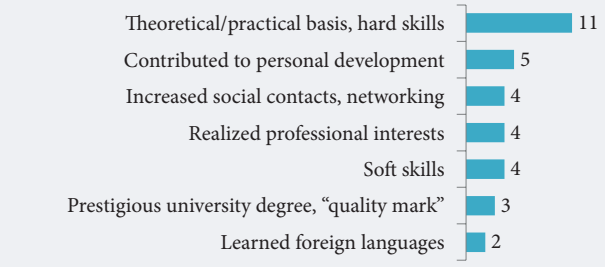
Source: composed by the authors.

On the whole, the graduates' positions turned out to be similar, summed up by the following quote: *"… after the two years in the Master's program, aspects beyond the daily workload became much more clear, which previously appeared to be blurred by distance" (respondent 7, track CS)*. Some of the graduates stressed the importance of research skills they acquired: *"The Master's program provides an understanding of how research should be structured, which techniques and data sources should be used in specific cases. In the light of this understanding, analytical materials are perceived differently: you can assess the quality of the authors' logic… Working on my Master's thesis helped me forge the ability to produce and structure analytical papers for the ministry's officials" (respondent 1, track PA)*.

For half of the respondents, the program opened new opportunities, new career and academic prospects. According to one of them, *"the courses I took first of all helped me find my way at the new job, and secondly, served as a good foundation for further development in the chosen area, including post-graduate studies" (respondent 15, track R&D)*. The graduates were able to focus on a specific professional area, and learn its specific features. Furthermore, both respondents representing the entrepreneurial track noted the program's role in their decision to start their own business: *"It was very important for me to get a broad understanding of Foresight techniques, strategic business planning, market studies tools, which resources were required to enter the market, investing, and minimizing risks" (respondent 10, track S)*.

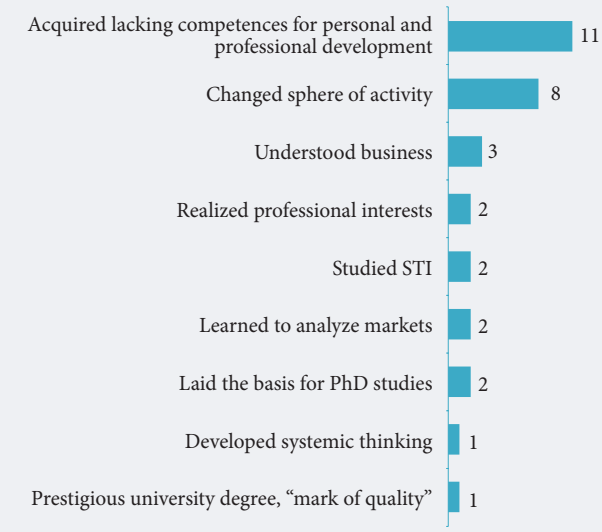
The third human capital element, development, allows one assess the mechanisms for increasing it through professional upgrading. Online education courses were the most popular format (applied by 15 of the 16 respondents), first of all in areas such as analytics, statistics, business models, and design. Training got the second largest number of mentions (10), with emotional intelligence development playing a particularly important role (mentioned by four respondents). Other ways to upgrade one's qualifications mentioned by the respondents included corporate training programs, further professional education courses, and PhD programs (Table 2).

Figure 2. **Bachelor Degree Value (number of mentions)**



Source: composed by the authors.

Figure 3. **Master degree value (number of mentions)**



Source: composed by the authors.

Regardless of the career path,[1] the respondents (four answers) did have opportunities to increase their human capital by taking part in relevant short-term training events including business training (three mentions). Graduates working for consulting firms used these opportunities most frequently: *"The company holds in-house training events all the time, in various areas" (respondent 7, track CS)*.

Apart from organized professional upgrading formats which can be seen as formal education, the graduates were engaged in informal educational activities including self-learning (Table 3). The main one was reading literature, first of all business and academic publications (three mentions each). The surveyed also mentioned taking part in professional events such as conferences, workshops, business case study analysis competitions, and so on.

The fourth group of questions were intended to assess the role of specialized skills and their application at work. The importance of seven key professional competences was rated using a 10-point scale. The average scores are presented in Figure 4.

All of the above skills were sufficiently important to the respondents. Still, they put social intelligence ahead of all others (giving it 8.9 points out of 10). In a situation of increasingly rapid robotization leading to job cuts [MGI, 2017], the graduates believed that having unique knowledge and practical skills became a key asset in defining people's competitiveness. The ability to establish partnerships and effi-

[1] Except startup owners.

Table 2. **Professional upgrading mechanisms**

Type	Name/subgroup	Number of mentions
Online courses (14 mentions)	Analytics and statistics courses (Big Data, DataCamp, Python)	6
	Business model and strategic design courses (product monetisation, strategic design, Skillbox UX analytics)	3
	Websites and applications to extend one's horizon	3
	Other training courses	2
Trainings (10 mentions)	Training courses to advance emotional intelligence	4
	Leadership trainings (SEO, Outbound Sales, Greenhouse program to advance leadership qualities and learn new approaches and techniques for analysts and consultants)	3
	Management trainings (IT Project Management, Information Security Management)	3
Short-term training events (4 mentions)	Business trainings (Accenture, EY, Yandex)	3
	Educational and social events at ministries	1
Continuing professional education (3 mentions)	Upgrading courses (at HSE University, project management at government agencies, business analytics)	3
PhD programs (2 mentions)	PhD programs from the leading universities in the United Kingdom and Belgium	2

Source: composed by the authors.

ciently negotiate also plays a key role in professional development.

It was suggested that the social intelligence concept itself was changing: *"Social intelligence used to be measured by the number of contacts in one's address book but then social networks arrived, along with thousands of contacts" (respondent 6, track CS).* In a professional community, communicating, and working under stress while multitasking requires developed emotional intelligence, which the respondents judged to be the second most important skill in this group (7.7 points out of 10). Many noted the importance of controlling one's own emotions. The third most sought-after competence turned out to be digital skills (7.5 out of 10). Several graduates also noted data analysis competences: *"You must be able to analyze and visualize any kind of data. Programming skills help with that. Such abilities allow one to extract valuable knowledge out of unconnected fragments"* (*respondent 13, track R&D*). The importance of such skills was probably due to the fact that as the volume of available data grows, companies began using quantitative data to support decision-making more often [EIU, 2013].

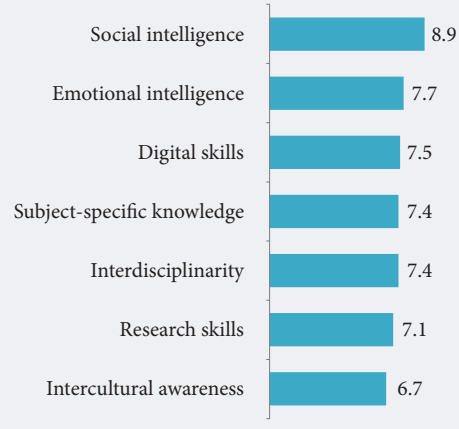
Subject-specific knowledge and interdisciplinary interaction skills were given identical scores (7.4 out of 10). This matches the T-shaped professional concept suggested by [*Guest,* 1991], which is based on the idea of developing a comprehensive personality combining deep knowledge with broad competencies. According to this logic, each worker has "two axes": horizontal (general competences) and vertical (special knowledge) ones.

The above concept becomes more relevant due to the need to handle the ever-increasing data flows. This was illustrated by one of the respondents: *"You cannot possibly have specific knowledge about every kind of task you deal with, but that's where your basic portfolio of knowledge and methodological approaches comes in to help" (respondent 1, track PA).*

The Master's program graduates received knowledge that helps them approach any analytical or prognostic task in a more systemic way. They assessed their training as multidisciplinary. At the same time the program allowed them to build individual career paths in terms of advancing specific knowledge and learning best STI practices and approaches alike.

The training also helped acquire research skills, whose importance the graduates assessed at 7.1 points. These include ability to think critically and identify core aspects in large data arrays. Only a few of the surveyed believed intercultural aware-

Figure 4. **Importance of key science, technology, and innovation skills (points out of 10)**



Source: composed by the authors.

Table 3. **Informal upgrading practices (self-learning)**

Type	Name/subgroup	Number of mentions
Reading literature (9 mentions)	Business literature	3
	Academic literature	3
	Books recommended by leading consultants (Big-3 and Big-4)*	1
	News media	1
	Industry-specific analytics	1
Conferences, exhibitions, business case studies, workshops (5 mentions)	Total *Out of that:*	5
	HSE events	1
	Events for entrepreneurs hosted by the Moscow City Business Development Department	1

* Note that the graduates recommended the following books: A. Auzan "Economics of Everything" [*Auzan,* 2014]; A. Osterwalder "Value Proposition Design" [*Osterwalder et al.*, 2014], D. Kahneman "Thinking, Fast and Slow" [*Kahneman*, 2011], D. Eagleman "Incognito: The Secret Lives of the Brain" [*Eagleman*, 2011], B. Dawn-Michelle "Kind Regards" [*Dawn-Michelle,* 2007], M. Gladwell "The Tipping Point: How Little Things Can Make a Big Difference" [*Gladwell,* 2000].

Source: composed by the authors.

ness skills were critically important, so their average score was the lowest, at just 6.7 points. Looking at the scores graduates assigned to various competences over the years, one can see that the importance of subject-specific knowledge was declining while that of emotional intelligence was growing (Table 4). This trend reflects the increasingly popular belief that lack of knowledge about a specific subject can be replenished quite rapidly these days while the development of soft skills, emotional intelligence in particular, takes much longer [*Haase, Lautenschlager,* 2011].

One of the respondents shared their personal experience of replenishing insufficient subject-specific knowledge while broadening their professional interests: "*You can accumulate knowledge rather quickly these days… and feel at home in a new area literally in a month or two" (respondent 9, track CS)*. However, this result should be treated with caution since the respondents' distribution by career paths was not proportional: the graduates working at R&D centers completed their studies in the program in 2016-2017, while half of the respondents representing the corporate sector graduated in 2018.

As to the factors that determine professional success, the corporate sector representatives valued the ability "*to take an objective and see it through*" particularly highly (respondent 9, track CS). Accordingly, they were interested not so much in having subject-specific knowledge as such, as acquiring the skills needed to apply this knowledge in practice. These workers were willing to learn basic theories, and over the course of their Master's education would like to get insights about their application in practical projects. In other words, they wanted to absorb information while conducting business case studies, modeling, and experimenting.

In its turn, working at R&D centers implies ongoing self-advancement in a specific domain, the ability to communicate with various people and learn useful competences from them: *"A specific feature of this work is the need to move on all the time. If you stop even for moment you immediately begin to lag behind" (respondent 13, track R&D)*. For graduates who chose this track, research competences were particularly important. However, they urged future students not to forget about applied aspects either, including best business practices.

For people running their own business, teamwork skills had key importance (coordinating, negotiating) as well as and priority-setting abilities.

Both representatives of this career path noted that finding new ideas and promoting creativity were turning into core competences in this field: *"It's not at all easy to put aside the ideas society imposes on you. But it's the only way to succeed, and achieve inner satisfaction" (respondent 11, track S)*.

The sole representative of the public sector assigned the highest importance to subject-specific knowledge and advanced social intelligence as the basis for shaping and implementing evidence-based government policy: *"Civil servants must have knowledge of financial, economic, and legislation-related issues, apply management skills in their daily activities, correctly communicate and establish contacts with professionals of various ages and persuasion" (respondent 1, track PA)*. They recommended that in the course of their studies, future Master's students should pay more attention to the program's management component and improve their knowledge of management.

Table 4. **Assessment of key STI-related skills' importance by graduation year**

Skills	2016	2017	2018
Research skills	7.8	6.6	6.8
Interdisciplinarity	7.6	7.2	7.5
Intercultural awareness	6.2	7.4	6.5
Subject-specific knowledge	8.2	8.0	6.2
Social intelligence	8.2	9.4	9.0
Digital skills	7.4	9	6.3
Emotional intelligence	6.0	7.6	9.2

Source: composed by the authors.

Conclusions

The labor market is being rapidly transformed by digitalization, which makes it necessary for workers to constantly advance their skills and acquire new competences. The goal of this study was to determine the role of human capital in professional development, using graduates of a relevant Master's program designed to train STI professionals as an example. We conducted in-depth interviews with 16 respondents representing various activity areas (public administration, the corporate sector, start-ups, and research institutes).

The study results confirmed most of the suggested hypotheses. Graduates value their higher education very much, though they assess participation in Bachelor's and Master's programs differently. The main advantages provided by the first of the aforementioned formats included a strong theoretical and practical basis, a broader scope for professional and personal development, networking, and the development of soft skills. As to the main benefits of Master's programs, the respondents mentioned additional competences and increased career potential.

In terms of practical application, the acquired knowledge helped the respondents to correctly conduct research using Foresight methodology and analyze and predict changes on the market. The Master's program helped them acquire teamwork skills, intercultural awareness, stress resistance, self-organization, and critical thinking abilities. Upgrading qualifications also plays a huge role in human capital development. The most popular form of achieving this was taking online educational courses.

Individual self-education practices were also identified, such as reading literature, participating in conferences, exhibitions, and workshops. Behavioral skills such as social and emotional intelligence and digital competences were particularly important for the STI sphere.

On the whole, regardless of their career path, the graduates noted the importance of the dynamic learning environment the Master's program created. Teamwork skills were naturally fostered while implementing joint projects. It also contributed to advancing interdisciplinary cooperation skills and making better decisions by pooling all team members' knowledge.

In terms of specific career paths, general management and project management studies were particularly important for graduates planning to work in public administration. Those oriented towards the corporate sector would welcome more active involvement of business experts and practitioners as teachers. This group displayed a growing interest in applying the knowledge they receive in practice. This demand can be met by providing information about various case study competitions and supporting students' participation in such events. For graduates interested in an academic career, tools to involve them in research activities of the faculty or division implementing the program should be developed. Representatives of various career paths noted the need to learn information handling skills during their participation in the program, such as processing and analyzing large volumes of unstructured data.

A limitation of this study was that the sample comprised only graduates of the single Master's program. Benchmarking or analyzing the best international STI-relevant teaching practices could produce more detailed results. The effect of the graduates' previous education (participation in Bachelor's programs) on their subsequent professional development remained outside the scope of the study.

Keeping in mind the intercultural nature of the program, specific features of Russian and international students should be identified. The sample used in the current study was small and not balanced in terms of representing various career paths. For example, public administration was represented by a single respondent. Extending the sample and making sure the graduates are more evenly distributed between career tracks would allow one to obtain deeper insights regarding the required skills and factors affecting successful development in the context of specific career paths.

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