INTEGRATION OF EDUCATION. Vol. 26, No. 3. 2022

ISSN 1991-9468 (Print), 2308-1058 (Online) http://edumag.mrsu.ru

УДК 373.6(470+571)

doi: 10.15507/1991-9468.108.026.202203.449-465

Original article

Schoolchildren's Perceptions of STEM Professions and Careers in Russia: Results of a Pilot Study

E. M. Kolesnikova [a] ✉, *I. A. Kudenko* [b]

[a] *Institute of Sociology – Branch of the Federal Center of Theoretical and Applied Sociology of the Russian Academy of Sciences, Moscow, Russian Federation*

[b] *Kudenko Consulting Ltd. – Global Evaluation and Research Services, Berkshire, UK*

✉ *kolesnikova@mail.ru*

Absrtact

Introduction. The world of work is undergoing a global shift fuelled by technological innovation, demographic changes and environmental problems. This heightens the demand for STEM (science, technology, engineering and math) competencies which are seen as a catalyst for social and economic development. The purpose of this study was to investigate learner views on STEM professions, the learners' overall attitudes regarding STEM, as well as their aspirations and willingness to choose a career in STEM and identify factors which are crucial in forming young people's interests in studying STEM and pursuing STEM careers.

Materials and Methods. This pilot study was conducted in May 2019 across three schools in the Moscow region. The authors used a slightly modified version of the learner questionnaire used by the European study "ECB-inGenious" to investigate perceptions of STEM careers among Russian learners in grades 8–9 and 10–11.

Results. Overall, it was determined that a combination of intrinsic (cognitive and attitudinal) and extrinsic (social, cultural and economic) factors were responsible for learner engagement in STEM. Learners showed a strong awareness of STEM's significance to society and displayed positive perceptions of STEM careers, although jobs in industry appeared less popular than those in other areas of STEM. Some factors, such as a learner's personal experiences of STEM in and out of the classroom can even play a decisive role in shaping aspirations towards STEM careers. Younger learners expressed more enthusiasm for STEM careers than their older counterparts. Learners enrolled in classes specialising in STEM and learners whose parent(s) worked in STEM-related professions showed stronger positive attitudes to STEM careers.

Discussion and Conclusion. To make an informed decision, learners require practical information and advice regarding STEM careers; schools can play an important role in this process. This guidance must begin early, ideally from primary school when learners are more enthused and interested in learning about STEM careers. It is also advisable for learners to be given more opportunities to join extracurricular STEM activities; consequently, a learner's understanding of STEM subjects is expanded outside the academic curriculum which can spark a long-lasting interest in the subject. Additionally, STEM subjects' curriculums require enriching with real-life examples and should be contextualised in terms of relevant careers. Finally, schools should be encouraged to organise regular engagements with STEM professionals.

Keywords: sociology of professions, engineer, reproduction of engineering personnel, STEM, school, career guidance, career choice, gender stereotypes, bayesian approach

Conflict of interests: The authors declare no conflict of interest.

For citation: Kolesnikova E.M., Kudenko I.A. Schoolchildren's Perceptions of STEM Professions and Careers in Russia: Results of a Pilot Study. *Integration of Education*. 2022;26(3):449–465. doi: https://doi.org/10.15507/1991-9468.108.026.202203.449-465

Научная статья

Представления школьников о STEM-профессиях и карьере в России: результаты пилотного исследования

Е. М. Колесникова[1]✉, *И. А. Куденко*[2]
[1] *Институт социологии Федерального научно-исследовательского социологического центра Российской академии наук, г. Москва, Российская Федерация*
[2] *Куденко консалтинг – глобальные услуги по оценке и исследованиям, г. Беркшир, Великобритания*
✉ *kolesnikova@mail.ru*

Аннотация
Введение. Мир труда переживает глобальные изменения, вызванные технологическими инновациями, демографическими изменениями и экологическими проблемами. Это повышает спрос на компетенции в области STEM (наука, технологии, инженерия и математика), которые все чаще рассматриваются как катализатор социального и экономического развития. Цель исследования – оценка мнений школьников на STEM-профессии, общего отношения студентов к STEM-образованию, а также их стремления и готовности выбрать карьеру в STEM и определить факторы, имеющие решающее значение для формирования интересов молодых людей к изучению STEM и выбору карьеры в данной сфере.
Материалы и методы. Настоящее пилотное исследование было проведено в мае 2019 г. в трех школах Москвы. Авторы использовали модифицированный опросник европейского исследования ECB-inGenious для изучения представлений о карьере STEM среди российских учащихся 8–9 и 10–11 классов.
Результаты исследования. По итогам исследования выявлено сочетание внутренних (когнитивных и поведенческих) и внешних (социальных, культурных и экономических) факторов. Школьники продемонстрировали глубокое понимание важности STEM-образования в обществе и позитивное восприятие профильных рабочих мест, однако рабочие места в промышленности для них менее привлекательны, чем в других областях STEM. Младшие школьники проявили большую заинтересованность относительно STEM-специальностей, чем старшие. Учащиеся классов, специализирующиеся на STEM, а также те, чьи родители профессионально связаны со STEM, продемонстрировали более позитивное отношение к STEM-образованию. Доказано влияние школы на выбор учениками STEM-карьеры.
Обсуждение и заключение. Результаты исследования вносят вклад в анализ проблематики выбора профессии старшеклассниками, перехода от образования к рынку труда. Материалы статьи будут полезны как практикам в профориентационной работе в школе, так и социальным исследователям.

Ключевые слова: социология профессий, инженер, воспроизводство инженерных кадров, STEM, школа, профориентация, выбор профессии, гендерные стереотипы, байесовский подход

Конфликт интересов: авторы заявляют об отсутствии конфликта интересов.

Для цитирования: Колесникова Е. М., Куденко И. А. Представления школьников о STEM-профессиях и карьере в России: результаты пилотного исследования // Интеграция образования. 2022. Т. 26, № 3. С. 449–465. doi: https://doi.org/10.15507/1991-9468.108.026.202203.449-465

Introduction

The world of work is undergoing a global shift fuelled by technological innovation, demographic changes and environmental problems. This heightens the demand for STEM (science, technology, engineering and math) competencies which are seen as a catalyst for social and economic development[1]. Prior to the COVID-19 pandemic this demand was well acknowledged by researchers and politicians but remained less visible to the broader public. The pandemic wreaked havoc on conventional working patterns and brought first-hand experience of

[1] OECD Skills for Jobs [Electronic resource]. 2018. Available at: https://www.oecdskillsforjobsdatabase.org/data/Skills%20SfJ_PDF%20for%20WEBSITE%20final.pdf (accessed 15.10.2021).

remote working, learning and socialising to millions of ordinary people. In turn, this amplified the demand for innovative technologies and digital solutions and made digital literacy a basic need and a new human right.

Although the rate of economic and technological changes has varied across sectors and geographies, STEM educated workforces are likely to be driving economic growth for many years to come; for instance, both the EU and USA reported that the growth in STEM employment over the last decade has significantly outpaced other sectors of the economy[2] whilst also generating a high-earnings premium for individuals with a STEM degree, even if they work in non-STEM professions[3] [1]. A similar pattern can now be observed in Russia [2]. As new digital-technology advances enter all sectors, a new ambiguity is introduced to what qualifies a job as a STEM profession. Since the onset of the Covid pandemic, this trend has greatly accelerated and, with time, STEM jobs could no longer be associated solely with STEM occupations [1].

Furthermore, it has been argued that scientific literacy and technology skills are necessary for effective participation in democratic deliberation; hence, STEM is best defined as a cultural activity to promote democracy, citizenship and social justice [3–5]. The United Nations' 2030 Strategy for Sustainable Development envisions STEM education as the main driving force to uplift entire communities by bringing economic, health and cultural benefits, including gender equality and social mobility[4]. This puts a special emphasis on the quality and accessibility of STEM education, both within the school curriculum and as out-of-school experiences [6–8]. In Russia, 2021 was declared the year of science and technology and policies were introduced intended to help attract gifted and talented young people to STEM[5].

Literature Review

The prominence of STEM in society has prompted many research and policy initiatives to improve STEM education. In research, there was a recognized need for better theoretical and empirical understanding of the phenomena as well as for more practical evidence of what works. There were numerous national and international studies on the factors affecting STEM learning and career aspirations [8–10]. In the second decade of the millennium, this research agenda was enriched by the additional focus on social inclusion, equity and mobility[6] [11]. Overall, research separates intrinsic (i.e. cognitive and attitudinal) and extrinsic (i.e. social, cultural and economic) factors affecting young people's perceptions and preferences regarding STEM learning and choices of career pathways [12].

The critical role of personal STEM experiences in shaping young people's interests, career perceptions and behaviours was also acknowledged[7]. In this regard, it is worth noting the concept of *science capital*

[2] Caprile M., Palmen R., Sanz P., Dente G. Encouraging STEM Studies for the Labour Market [Electronic resource]. 2015. Available at: https://www.europarl.europa.eu/RegData/etudes/STUD/2015/542199/IPOL_STU%282015%29542199_EN.pdf (accessed 15.10.2021); Zilberman A., Ice L. Why Computer Occupations Are Behind Strong STEM Employment Growth in the 2019–29 Decade / Beyond the Numbers: Employment & Unemployment, vol. 10, no. 1 (U.S. Bureau of Labor Statistics, January 2021) [Electronic resource]. Available at: https://www.bls.gov/opub/btn/volume-10/why-computer-occupations-are-behind-strong-stem-employment-growth.htm:Retrieved6/21/2021 (accessed 15.10.2021).

[3] Noonan R. STEM Jobs: 2017 Update [Electronic resource]. 2017. Available at: https://www.commerce.gov/sites/default/files/migrated/reports/stem-jobs-2017-update.pdf (accessed 15.10.2021).

[4] 3 Ways STEM Education Benefits Developing Countries: Tryengineering.org 3 [Electronic resource]. Available at: https://tryengineering.org/news/3-ways-stem-education-benefits-developing-countries (accessed 15.10.2021).

[5] [The Year of Science and Technology] [Electronic resource]. Available at: https://xn--80afdrjqf7b.xn--p1ai (accessed 15.10.2021). (In Russ.)

[6] UNESCO. Cracking the Code: Girls' and Women's Education in Science, Technology, Engineering and Mathematics (STEM) [Electronic resource]. 2017. Available at: https://www.euagenda.eu/upload/publications/untitled-137226-ea.pdf (accessed 15.10.2021).

[7] Sjøberg S., Schreiner C. The ROSE Project. An Overview and Key Findings [Electronic resource]. 2010. Available at: https://roseproject.no/network/countries/norway/eng/nor-Sjoberg-Schreiner-overview-2010.pdf (accessed 15.10.2021).

which was developed within the UK project ASPIRES, a longitudinal study of the school children's science experiences and dispositions[8] [13]. Drawing from the sociology of Pierre Bourdieu and, specifically, his notion of social capital, *science capital* refers to science-related knowledge, attitudes, experiences and resources acquired by an individual throughout their life [11; 14]. This includes who you know and what sort of everyday engagement you have with science. It is important because it directly influences a young person's disposition towards STEM. The researchers concluded that an increase in *science capital* makes a pupil more likely to continue learning STEM subjects post-16 and aspire to a STEM-related job.

The findings of the ASPIRES project echoed the insights from other research studies that identify the lack of relevance of the STEM curriculum to STEM-related careers as a serious barrier to good STEM education [12]. They argue that to be interesting and engaging, STEM teaching must be enriched with real life and industry examples relevant to the lives of young people and needs of the economy or society in general[9]; it must also contain up-to-date information on career options and pathways to achieve them[10]. Equally, traditional teaching needs to be enhanced with inquiry-based learning, research engagement and other pedagogies supporting active learning [15]. However, schools and teachers often lack relevant expertise and resources for STEM enrichment and need external support, which makes a good case for closer involvement of businesses and industry in school education[11] [16]. The engagement of STEM employers comes in various shapes and forms: this ranges from providing learning resources and role models, to arranging study visits and competitions, to offering mentoring, apprenticeships and job experience, to establishing long-lasting partnerships with schools and other providers of STEM education[12] [10].

While STEM enrichment can be a game-changer for STEM education nationally and internationally, this experience needs careful examination to generate reliable evidence of what works in different environments and circumstances. One of the large-scale European initiatives set up to address this evidence gap was the multi-stakeholder project "ECB-inGenious" (2011–2014), involving over 40 partner organisations representing European industry, policy makers and STEM educators [12]. The overarching aim was to foster young Europeans' interest in STEM education and careers by supporting collaboration between STEM educators and employers. It was particularly designed to address two specific challenges: lack of interest in STEM subjects and the anticipated future skills gaps in Europe. To this purpose, ECB-inGenious facilitated school-industry partnerships and the development of innovative STEM educational practises designed by STEM industry partners.

While the body of research on STEM opinions and career preferences of young people is growing, there remains an information gap regarding (a) the role and nature of STEM learning experiences in and out of school; (b) how well the careers guidance system meets the needs of the society by helping

[8] Archer L., Moote J., MacLeod E., Francis B., DeWitt, J. ASPIRES 2: Young People's Science and Career Aspirations, Age 10–19 [Electronic resource]. London: UCL Institute of Education; 2020. Available at: https://discovery.ucl.ac.uk/id/eprint/10092041/15/Moote_9538%20UCL%20Aspires%202%20report%20full%20online%20version.pdf (accessed 15.10.2021).

[9] Careers Development Institute. Why Does Employer Engagement Matter? A Tool Kit for Managing Employer Activities in Schools and Colleges [Electronic resource]. 2014. Available at: http://www.thecdi.net/write/Why_Does_Employer_Engagement_Matter_A_Toolkit_for_Managing_Employer_Activities_in_Schools_and_Colleges.pdf (accessed 15.10.2021).

[10] CEC & CBI. How to Support Careers and Enterprise Activities in Schools: A Practical Guide for Employers [Electronic resource]. 2017. Available at: https://www.youthemployment.org.uk/dev/wp-content/uploads/2018/04/careers-enterprise-cbi-employers-guide-schools-v2.pdf (accessed 15.10.2021).

[11] European Schoolnet: website [Electronic resource]. Available at: http://www.eun.org/resources/publications (accessed 15.10.2021).

[12] Mann A., Rehill J., Kashefpakdel E. Employer Engagement in Education: Insights from International Evidence for Effective Practice and Future Research [Electronic resource]. 2018. Available at: https://educationendowmentfoundation.org.uk/public/files/Employer_Engagement_in_Education.pdf (accessed 15.10.2021).

young people transition from education to the modern world of employment which demands more STEM skills and qualifications.

Materials and Methods

This pilot study was conducted in May 2019 across three schools in the Moscow region. We used a slightly modified "ECB-inGenious" questionnaire for secondary school learners to investigate STEM views and experiences of Russian learners in grades 8–9 (13–16 years old) and 10–11 (15–18 years old) (n = 305). In accordance with the principles of ethical research, learners were informed about the research purposes, how their data will be used and the voluntary nature of participation[13].

The female/male gender ratio in the sample was 47%/53% and just under half of them (n = 150) reported studying in specialist STEM classes, i.e. classes that in addition to the standard curriculum contain additionally taught elements of 'specialist' disciplines (e.g., natural sciences, engineering, IT, medicine, etc.). The remaining 155 learners reported that their classes specialise in non-STEM disciplines or have no specialism at all. The exact breakdown of the cohorts is shown in Table 1 below.

One of the modifications made to the original questionnaire was to add a *science capital* measure to account for any professional STEM connections within the learner's immediate family. In our sample, nearly two thirds of learners (n = 199) indicated someone in their close environment was employed (at the time of the survey or in past) in STEM-related professions (engineering, medicine, natural sciences). Interestingly, just under half of these learners (n = 97) were from the classes specialising in STEM subjects whilst the rest were from non-STEM classes.

Although the sample was sufficient for the purpose of the pilot study, the findings need to be treated with some caution; by uncovering certain patterns in the STEM perceptions of Russian teenagers, the study helped to refine the research questions and instruments, thus paving the way for a future large-scale study of young people's STEM experiences and perceptions.

The research questions of the pilot study were:

– How do young people in Russia perceive the STEM industry and jobs?

– What are the respondents' experiences of STEM participation and attitudes towards STEM learning and careers?

Table 1. **Breakdown of the secondary school learners' cohorts** (n = 305)

Specialism	Total	Gender		Grades	
		male learners	female learners	8–9	10–11
STEM-related	**150**	**80**	**70**	**84**	**66**
including					
engineering	92	49	43	43	49
science	9	7	2	7	2
mathematics	25	17	8	25	0
medical	24	7	17	9	15
non-STEM	**155**	**63**	**92**	**101**	**54**
including					
human/social sciences	79	21	58	32	47
military cadets	38	22	16	38	0
no specialism	38	20	18	31	7
Overall	**305**	**143**	**162**	**185**	**120**

[13] The study was conducted in accordance with the Code of Ethics and Official Conduct of Employees of the Federal Research Center of the Russian Academy of Sciences. Available at: https://www.fnisc.ru/files/File/FNISC_kodeks_etiki.pdf (accessed 15.10.2021).

– What is the value of the concept 'science capital' when studying career aspirations of young people in Russia?

Some findings of the pilot study were published earlier, including a comparative review of opinions on STEM education of Russian and European learners [17] and a gender-focused analysis [18]. Those findings are only briefly described here. Instead, the focus of this article is an additional aspect of the research which explores how learners perceive specific STEM careers.

Results

Views on STEM Professions. A set of questions in the survey was aimed at measuring learners' perceptions of the STEM industry and related professions. Learners were offered a mixed list of positive (10), negative (10) and gendered (3) descriptors and asked to select the top five that in their view best describe the industry / manufacturing sector. Learners were offered the opportunity to leave their own independent comments. A similar method was used for obtaining their views on the following groups of STEM-related professions: jobs in industry and manufacturing; professions in life sciences and jobs related to mathematics. The respondents were asked to select from a list of adjectives that best described their overall opinions on the relevant profession.

On the whole, when describing their feelings towards STEM jobs, learners used positive attributes more frequently than negative ones: on average they selected 3.8 positive and 2.2 negative attributes per profession, but there were some noticeable differences (see Table 2 below).

The main differences were found to be age-related. As a general rule, learners in grades 8–9 evoked more positive responses than learners in grades 10–11. This seems to corroborate the findings from an earlier study [12] in terms of declining positive perceptions of STEM during secondary-to-high-school transition. The responses to professions relating to mathematics proved to be the exceptions: both older and younger learners rated them positively to the same extent. Interestingly, for learners specialising in STEM subjects, the perceptions of industry and science jobs were no different from the rest of the sample, but their views on mathematics-related jobs evoked a far more positive response. Learners enrolled in STEM classes used, on average, 4.3 positive terms and 1.7 negative terms, while other groups of learners offered more criticism, using 3.7 positive and 2.3 negative terms to describe mathematics-related professions (Table 2).

We have also observed the importance of science capital. Learners with parents working in STEM-related professions tended to share more positive views on science and mathematics-related professions, but not industry jobs which received mixed ratings. Children of scientists were significantly more likely to express positive views on professions related to mathematics. Overall, industry jobs were rated similarly by learners with and without a parent working in a STEM discipline. This was largely due to the fact that the parents of learners working in science or medicine were surprisingly critical towards jobs in industry while learners whose parents actually worked in industry were marginally more positive toward these professions (Table 3).

T a b l e 2. **A visual breakdown of the average number of positive and negative attributes with respect to various STEM professions as selected by secondary school learners**

Average number of attributes selected by learners		All learners	Specialism		Grades	
			STEM	non-STEM	8–9	10–11
Industry jobs	Positive attributes	3.4	3.4	3.4	3.8	2.8
	Negative attributes	2.7	2.8	2.7	2.4	3.3
Jobs in science research	Positive attributes	4.0	4.0	4.0	4.5	3.6
	Negative attributes	2.0	1.9	2.0	1.7	2.3
Jobs in mathematics	Positive attributes	4.0	4.3	3.7	4.0	3.9
	Negative attributes	2.0	1.7	2.3	1.9	2.2

T a b l e 3. **Breakdown of the average number of attributes selected by secondary school learners' cohorts (continuation)**

Average number of attributes selected by learners		All pupils	Non-STEM parent(s)		Industry engineering parent(s)		Parent(s) in medical profession		Parent(s) in a science-related profession		Parent(s) in a life-science profession	
			yes	no	yes	no	yes	no	yes	no	yes	no
Industry jobs	N	305	217	88	113	192	81	224	30	275	50	255
	Positive attributes	3.4	3.4	3.3	3.5	3.3	3.3	3.4	3.4	3.4	2.9	3.5
	Negative attributes	2.7	2.7	2.8	2.5	2.9	3.0	2.6	3.6	2.6	3.2	2.7
Jobs in science research	Positive attributes	4.0	4.1	3.7	4.3	3.8	4.2	3.9	4.5	4.0	4.2	4.0
	Negative attributes	2.0	1.9	2.2	1.6	2.2	2.2	1.9	2.3	1.9	2.0	2.0
Jobs in mathematics	Positive attributes	4.0	3.9	4.0	4.1	3.9	4.2	3.9	5.3	3.8	4.3	3.9
	Negative attributes	2.0	2.0	2.0	1.7	2.2	2.2	1.9	1.4	2.1	1.7	2.1

As well as quantifying the positive and negative attributes for professions, an additional qualitative analysis was conducted in order to identify the top five[14] descriptors for each identified area of STEM professions (industry, science and mathematics-related), overall and disaggregated by gender (Table 4 below). By far the most popular attributes were 'well-paid' and 'for men and women'. These characteristics were chosen by over half of all respondents in relation to every area of the listed STEM professions. Two additional attributes, 'innovative' and 'high-tech', were commonly related to industry and science jobs. Furthermore, mathematics-related professions were viewed by the majority as 'safe' and 'reliable'.

Learners had a choice of three gender-based attributes: 'for men and women', 'for women' and 'for men'. Only a small group of learners (19% of learners in the sample) did not choose any gender-based attribute while the majority (81%) felt a gender-based attribute could be selected to describe STEM professions. The gender-equity statement 'for women and men' was by far the most popular (Table 4).

Analysing the findings further Bayesian analysis was employed and calculated conditional probabilities for each combination of word pairs from the set of 23 available attributes (253 pairs and 506 combinations) were calculated[15].

T a b l e 4. **The top 5 attributes selected by learners to describe STEM jobs (by percentage of respondents)**

Industry jobs		Science jobs		Jobs in mathematics	
Well-paid	52	Innovative	50	For men and women	52
Innovative	50	For men and women	50	Safe	52
High-tech	46	High-tech	47	Well-paid	50
Dirty	44	Well-paid	46	Reliable	42
For men and women	42	Rewarding	43	Rewarding	40

[14] On average, learners chose about 6 characteristics for each area of the STEM profession even though they were asked to choose just five attributes. This was possible because data was collected via paper questionnaires hence learners were able to select as many characteristics as they wanted. All selections were included in the analysis.

[15] For calculations of conditional probabilities, the authors used a supplementary data analysis package for MS Excel.

This methodology established the likelihood of an attribute being selected together with another in a pair, denoted by the conditional probabilities P(A|B) and P(B|A)[16]. By identifying the strongest probability relationships (where P(A|B) > 0.4) within each pair and grouping relevant pairs of attributes together, we established combinations or *Clusters* of attributes that had a high probability of being used together. Attributes that formed the highest number of strong associations within a Cluster formed the 'core' of any single Cluster.

For each category of STEM jobs two clearly identified Clusters were found, which suggested two opposing sentiments. At the core of all identified Clusters were terms describing interest and perceived reward from the following pairs of contrasting attributes: 'attractive'/'unattractive', 'boring'/'exciting', 'rewarding'/'disappointing'. It suggests that interest and reward form the basis of learner attitudes to STEM professions. The term 'attractive' was the centrepiece in every 'positive' Cluster we identified, just as its antonym 'unattractive' was at the core of every 'negative' set of attributes.

Industry Jobs. Learner views were very polarised and split into two equally weighted Clusters – one with all positive attributes and one with all negative attributes (Clusters 1 and 2 respectively). The terms 'attractive' and 'exciting' formed the core of Cluster 1, with 42% of learners choosing one or both of these terms (34% of female learners vs 51% of male learners). Other attributes identified in the positive Cluster were 'innovative', 'well-paid', 'high-tech', 'rewarding', 'reliable', 'popular', 'for men and women'. Cluster 2's core was a mirror image of Cluster 1, with the terms 'unattractive' and 'disappointing' at its centre. The terms were selected by the same number of learners (42%, including 49% of female learners and 34% of male learners). Other attributes associated with this Cluster were also negative: 'dirty', 'boring', 'dangerous', 'unpopular', 'for men and women', 'low pay' (Table 5, Fig. 1).

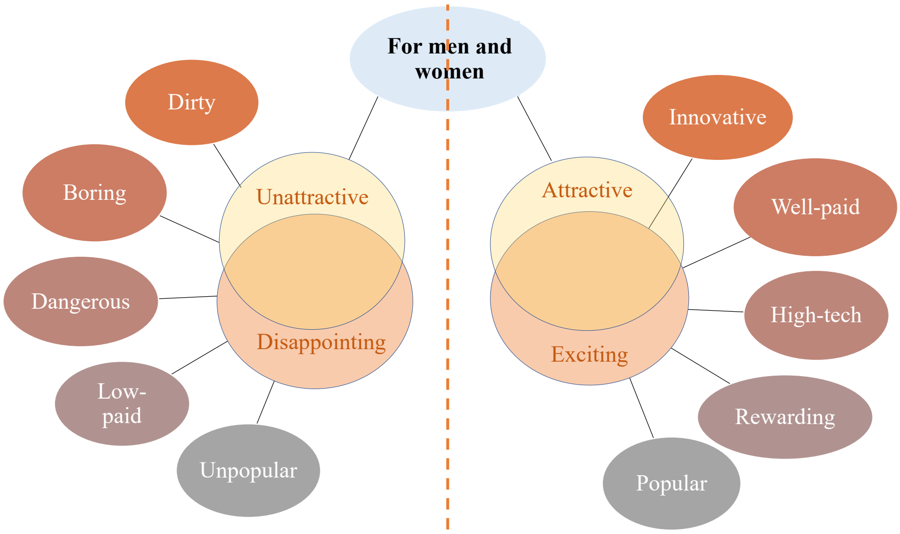
Science Jobs. The distribution of learner perceptions towards jobs in science mirrored learner perceptions of industry jobs closely. Two conflicting positive and negative attitudes were observed here, but the Clusters were not equal in size and not as clearly separated as with industry jobs (Tables 6 and 5 respectively). There were a number of positive attributes (e.g. 'clean', 'well-paid' and 'innovative') that had a high likelihood of being selected by both those who liked and disliked science jobs, which testifies to a more positive understanding of this category of STEM jobs.

Overall, science jobs were positively perceived by two thirds of learners (66%) and particularly favoured by female learners: 71% of female learners and 60% of male learners described them as 'rewarding', 'attractive' or 'exciting' (Cluster 1).

T a b l e 5. **Industry jobs: Conditional probability relationship between core and non-core attributes** (by percentage)

Cluster 1	Core attributes (n = 128)		Cluster 2	Core attributes (n = 127)	
	Attractive (n = 98)	Exciting (n = 85)		Unattractive (n = 103)	Disappointing (n = 75)
Innovative	60	70	Dirty	73	67
Well-paid	68	70	Boring	63	65
High-tech	53	64	Dangerous	47	51
Rewarding	47	47	Unpopular	47	44
Reliable	45	42	For men and women	46	51
Popular	37	46	Low-paid	51	64
For men and women	42	40			

[16] Jeliazkov I., Yang X. (eds). Bayesian Inference in the Social Sciences. New York City: Wiley; 2014. 350 p.



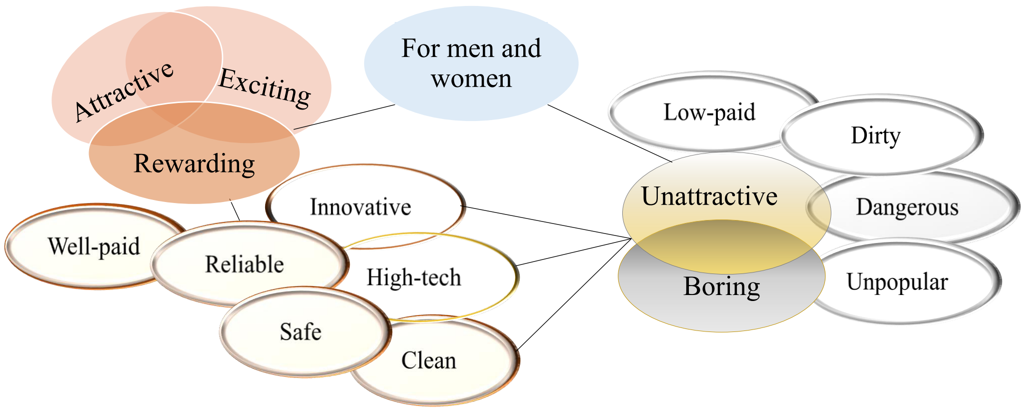
F i g. 1. Industry jobs: Visualisation of breakdown of the descriptors selected by secondary school learners

These statements were linked to other positive attributes, many of which resemble the learners' choices for industry jobs ('high-tech', 'innovative', 'popular' and 'well-paid') but there were a few additional items: 'reliable', 'safe' and 'clean'. Cluster 2 is formed around two negative attributes, 'unattractive' and 'boring'; this position describes the views of a third of learners (33% – 31% of female learners and 35% of male learners). The fact that these negative terms go hand in hand implies that science jobs are often considered unattractive because they are also perceived as boring and tedious in nature. Other negative attributes in this Cluster were 'low-paid' and 'unpopular'. However, in contrast to industry jobs, all learners, including those possessing critical views of science jobs, often selected one or two positive features (e.g. 'clean', 'high-tech', 'innovative') (Fig. 2).

Jobs in Mathematics. There are two main clusters of perceptions which resemble the polarising divisions observed with science and industry jobs. However, the distinction between the Clusters was less obvious, as many attributes were found to be of equal importance for those who both liked and disliked mathematics-related jobs.

T a b l e 6. **Science jobs: Conditional probability relationship between core and non-core attributes** (by percentage)

Cluster 1	Core attributes (n = 201)			Cluster 2	Core attributes (n = 101)	
	Rewarding (n = 131)	Attractive (n = 121)	Exciting (n = 116)		Boring (n = 78)	Unattractive (n = 76)
High-tech	56	57	58	Low-paid	50	51
Reliable	41	34	37	Unpopular	46	46
Popular	39	41	36	Dirty	32	34
				Dangerous	26	34
Innovative	60	57	53	Innovative	40	39
Safe	40	37	30	Safe	40	36
Clean	47	47	44	Clean	36	28
Well-paid	60	49	44	Well-paid	29	37
For men and women	61	66	59	For men and women	51	50



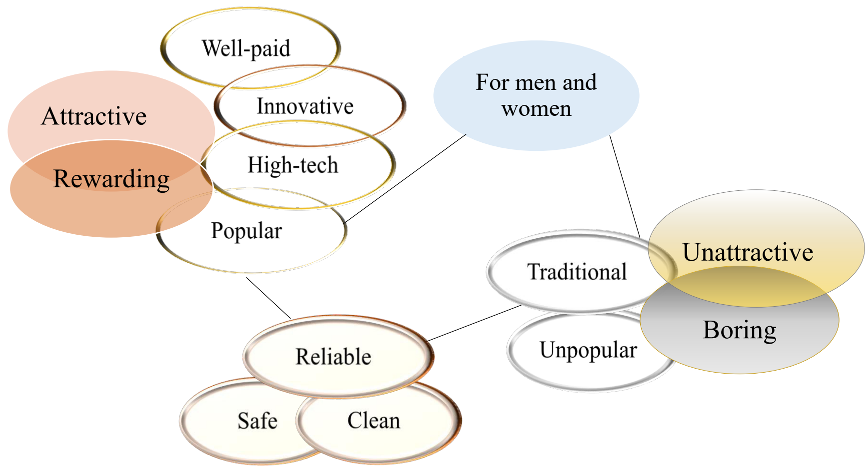
F i g. 2. Science jobs: Visualisation of breakdown of the descriptors selected by secondary school learners

The Cluster 1 with positive dispositions was centred around two closely-linked characteristics: ‘attractive’ and ‘rewarding’. This pair of attributes was selected by 57% of learners (55% of female learners and 60% of male learners). Interestingly, the notion of reward implied both the material reward (hence a pairing with the term ‘well-paid’) as well as social recognition (inferred from the pairing with the term ‘popular’). Jobs in mathematics were also widely perceived as reliable, which often went together with the terms ‘safe’ and ‘clean’. The negative Cluster was, again, centred around two core characteristics: ‘unattractive’ and ‘boring’. These attributes were selected by 43% of learners (44% of female learners and 42% of male learners). Other negative attributes associated with this Cluster were ‘traditional’ and ‘unpopular’ (Table 7).

Interest in STEM Education and Career Aspirations. In addition to learning about learner views on STEM professions, the study also investigated the learners’ overall attitudes regarding STEM, as well as their aspirations and willingness to choose a career in STEM. Additionally, a range of factors that could influence the learners’ interests and preferences, such as the learners’ experiences in careers education and the STEM backgrounds of relatives (i.e. science capital), were explored in more detail.

T a b l e 7. **Jobs in mathematics: Conditional probability relationship between core and non-core attributes** (by percentage)

Cluster 1	Core attributes (n = 175)		Cluster 2	Core attributes (n = 132)	
	Attractive (n = 117)	Rewarding (n = 123)		Unattractive (n = 94)	Boring (n = 114)
Well-paid	65	66	Traditional	40	51
Innovative	49	50	Unpopular	49	51
High-tech	47	46			
Popular	41	46			
Reliable	50	59	Reliable	37	42
Clean	52	60	Clean	39	43
Safe	56	54	Safe	60	63
For men and women	53	60	For men and women	61	61



F i g. 3. Jobs in mathematics: A graphic visualising the breakdown of the descriptors selected by secondary school learners

It was found that there was a relatively high learner interest in general matters concerning STEM, and some significant influence on an individual's career aspirations as a result of the family's careers.

In general, the views of Russian schoolchildren in our pilot study closely resembled the views of their European peers reported in the InGenious study [12]:

1. Most learners (70%) showed interest in topics relating to science and technology; however, only 48% reported engaging in STEM learning activities outside of mandatory learning in school.

2. Learners (79%) expressed confidence in the fact that the future demand for STEM professionals would grow; there was also a general consensus (63% of learners) that studying science is important for the learners' individual futures; furthermore, a majority (55% of learners) agreed that studying STEM is important, regardless of the career path undertaken.

3. When asked if they have the personal qualities and skills required for a career in STEM, 63% of learners affirmed 'yes'. However, only 47% wanted to pursue such a career, whilst 42% wanted more information about such professions.

4. Younger learners demonstrated more confidence in their own abilities and expressed more enthusiasm for STEM careers than their older counterparts: 52% of those in grades 8–9 stated that they would like a job related to life sciences or technology, and 70% of learner in this group believed that their personal qualities and skills were suitable for a career in STEM; in stark contrast, in grades 10–11, these numbers dropped to 39% and 53% respectively.

5. School is largely regarded by teenagers as a place for learning academic knowledge rather than practical information and advice about careers. More than half of all learners (56%) believed that they are not sufficiently informed about STEM-related professions at school; of those interested in a STEM career, only 47% said that they learned about STEM professions in school. This points to a poor utilisation of school as a career-guidance resource.

6. Expectedly, learners enrolled in classes specialising in STEM showed stronger positive attitudes to STEM careers and a greater confidence in having suitable personal qualities and skills (71% of STEM-specialist learners as opposed to 55% among other learners); they were also significantly more likely to be interested in working in STEM (67% vs 28%) and more of the learners desired to receive additional information regarding STEM professions (58% vs 26%).

7. Learners whose parent(s) worked in STEM-related professions showed similar tendencies: they were more likely, compared to learners whose parent(s) worked in

other sectors, to: consider a STEM career for themselves (52% vs. 38%); be interested in learning about STEM professions (46% vs. 35%); and reported having personal qualities and skills suitable for STEM professions (67% vs. 57%).

Discussion and Conclusion

Bridging the Gap between Positive Perceptions of STEM Jobs and Willingness of Young Adults to Choose a Career in STEM. It is sometimes assumed that because gadgets and technologies play such a big role in the life of modern young adults, this automatically translates to young adults being both knowledgeable and positive about STEM jobs; from this, some argue that there is no need for extracurricular education and motivation for the pursuance of STEM careers. The evidence from this pilot study challenges this assumption and corroborates the conclusion from previous international research [12]: having a general interest in STEM topics and recognising the role of STEM in society are not enough to motivate young people to choose STEM for a personal career. To pursue a STEM career, learners require a more tangible knowledge of STEM jobs and confidence in their own abilities multiplied by a genuine affinity towards specific jobs.

This paper's analysis of how attributes group together shows that material considerations are important but, on their own, they rarely become the main driving factor for choosing a STEM career. While young people appreciate the financial premium that accompanies STEM qualifications, anticipated increased wages are not enough to form a positive perception of the profession. The centrality of such emotive descriptions such as 'attractive' and 'exciting' suggests that in order to select a STEM career, a learner must possess inherent interest in the nature of the job, even when potential shortcomings of such a choice (e.g. 'dangerous') are also recognised. The other crucial ingredient is the self-affirmation that a career in STEM has the potential of success. This relies on clear understanding of STEM-related jobs and preferably some first-hand experience in the world of STEM professions, which makes *science capital* formed both at school and at home a powerful means to achieve this state.

For many learners, school remains the main place for encountering STEM; yet, these experiences are often focused on acquiring purely academic knowledge and lack real-life application and the development of practical skills. According to young adults, schools, as they are today, are not yet a place where learners can adequately learn about STEM-professions. Extracurricular education (i.e. STEM clubs), as well as parental support, may fill this void, but such resources are not accessible to all learners. Specialist STEM classes, where teaching of STEM subjects is often enriched with practical applications, provide a viable solution; however, if both quality education and career learning for all learners is desired, this approach needs to enter mainstream teaching.

Career Guidance at School and Gender Equality in STEM Related Jobs. While education and career guidance on their own cannot solve all the problems of gender inequality, it is nevertheless a very powerful mechanism to help bridge the gender gap in the world of STEM careers. A comprehensive school career-guidance system can help female learners gather more accurate information about the labour market, get experience in professions that are considered 'atypical' for females, and become more confident in personal professional skills and qualifications.

Career Guidance at School in Russia. STEM education in Russia benefited from the Soviet legacies where the STEM industry, research and mass STEM-literacy were top national priorities. To this day, this fact sees a great imprint on national culture. Soviet Russia had a large engineering sector, an extensive network of scientific research institutions, and a strong system of STEM education from primary to tertiary levels of education [19]. There was also a strong emphasis on building work-related knowledge and skills, which was delivered through school-industry partnerships ('shevstvo' or 'polytechnical education'), learner work experience programs and an extensive system of publicly funded and universally accessible STEM-clubs and other such extracurricular activities [20]. The end of the Soviet era in 1991 triggered significant economic and social shifts in the fabric of the society which brought a mixed fortune for STEM jobs and education.

In recent years, the popularity of STEM education is increasing, which has been aided by more state funding going into STEM economy and Higher Education, as well as a greater visibility of digital economy. The idea of developing 21st-century skills for all school children is becoming a popular notion; in particular, this is true for mathematical literacy and programming skills [21]. There are some positive examples in extracurricular education [22; 23]. Yet, while the state is trying to rebuild a system of providing scientific and technical activities for schoolchildren outside the curriculum [24–26], according to some research, this is accompanied by a growing social divide in terms of access to high quality STEM education and career learning [27–29].

In modern-day Russia, some partnerships between schools and local businesses can be observed; however, such relationships are most often created through a combination of personal initiative and networks of teachers and parents. Schools also differ in terms of what enterprises are available locally and if those enterprises are interested in partnership with the schools. There are no formal rules, no institutional knowledge and no organised structure to support such partnership arrangements. Even when partnerships are formed, not all of them are run efficiently or are long-lasting.

To summarise, even for the cases where schools would like partnerships to STEM professionals, who can introduce learners to the real world of modern professions, this is not an easy task. A system of institutionalised support for school-business partnership in STEM education and good career guidance would be a step in the right direction to help solve this issue.

Advancements in technology will continue transforming the labour market, intensifying the need for STEM specialists and STEM competencies. Although learners are generally interested in STEM topics and are generally proficient users of tech-gadgets, this does not necessarily translate to a desire to study and pursue a career in STEM. School remains, for the majority of learners, the focal point of all STEM experiences, whilst learners' exposure to extracurricular STEM activities and career guidance is limited. Consequently, the learner-body's knowledge regarding STEM professions remains scarce and fragmented, often relying on accidental learning. If this is to change, more needs to be done in and out of school to provide opportunities for learners to learn and experience STEM professions first-hand.

Several factors are known to play a role in determining a learner's views on STEM-related professions; these include: learner age; studying in classes specialising in STEM; and personally knowing someone who works in the STEM sector. These factors need to be taken into consideration when planning careers-education for learners. This guidance must begin early, ideally from primary school when learners are more enthused and interested in learning about STEM careers. It is also advisable for learners to be given more opportunities to join extracurricular STEM activities; consequently, a learner's understanding of STEM subjects is expanded outside the academic curriculum which can spark a long-lasting interest in the subject. Additionally, STEM subjects' curriculums require enriching with real-life examples and should be contextualised in terms of relevant careers. Finally, schools should be encouraged to organise regular engagements with STEM professionals.

School is likely to remain the main source of information about all STEM-related knowledge. However, school educators often lack relevant expertise and resources for STEM enrichment and require external support. Employer engagement in designing and delivering STEM activities could improve the quality of teaching and learning, and help increase learner interest and attainment in STEM disciplines. It can also raise awareness about the STEM industry and the jobs it offers as well as combating negative stereotypes, which are clearly ripe among the learners.

These are important questions and should be explored further in a full-scale study of STEM careers education and young people's aspirations in various regions of Russia. Another avenue to pursue would be exploring the current practises of collaboration between STEM employers and schools in Russia.

REFERENCES

1. Grinis I. The STEM Requirements of "Non-STEM" Jobs: Evidence from UK Online Vacancy Postings. *Economics of Education Review*. 2019;70:144–158. doi: https://doi.org/10.1016/j.econedurev.2019.02.005

2. Akhapkin N.Yu., Volkova N.N., Ivanov A.E. The Development of the Digital Economy and the Prospects for the Transformation of the Russian Labor Market. *Vestnik Instituta Ekonomiki Rossiyskoy Akademii Nauk*. 2018;(5):51–65. Available at: https://inecon.org/images/stories/publicacii/vesnik-ran/2018/VIE_RAS_5_2018.pdf (accessed 15.10.2021). (In Russ., abstract in Eng.)

3. Barton A.C., Greenberg D., Kim W.J., Brien S., Roby R., Balzer M., Turner C., Archer L. Disruptive Moments as Opportunities Towards Justice-Oriented Pedagogical Practice in Informal Science Learning. *Science Education.* 2021;105(6):1229–1251. doi: https://doi.org/10.1002/sce.21682

4. Cooper G., Berry A. Demographic Predictors of Senior Secondary Participation in Biology, Physics, Chemistry and Earth/Space Sciences: Students' Access to Cultural, Social and Science Capital. *International Journal of Science Education*. 2020;42(1):151–166. doi: https://doi.org/10.1080/09500693.2019.1708510

5. Godec S., Archer L., Dawson E. Interested but Not Being Served: Mapping Young People's Participation in Informal STEM Education through an Equity Lens. *Research Papers in Education*. 2022;37(2):221–248. doi: https://doi.org/10.1080/02671522.2020.1849365

6. Davis K., Fitzgerald A., Power M., Leach T., Martin N., Piper S., Singh R., Dunlop S. Understanding the Conditions Informing Successful STEM Clubs: What Does the Evidence Base Tell Us? *Studies in Science Education*. 2021. doi: https://doi.org/10.1080/03057267.2021.1969168 (In Print)

7. Dockery A.M., Bawa S., Coffey J., Li I. W. Secondary Students' Access to Careers Information: The Role of Socio-Economic Background. *Australian Educational Researcher*. 2021. doi: https://doi.org/10.1007/s13384-021-00469-1 (In Print)

8. Dodd V., Hanson J., Hooley T. Increasing Students' Career Readiness through Career Guidance: Measuring the Impact with a Validated Measure. *British Journal of Guidance & Counselling*. 2022;50(2):260–272. doi: https://doi.org/10.1080/03069885.2021.1937515

9. Hoff K.A., Van Egdom D., Napolitano C.M., Hanna A., Rounds J. Dream Jobs and Employment Realities: How Adolescents' Career Aspirations Compare to Labor Demands and Automation Risks. *Journal of Career Assessment.* 2022;30(1):134–156. doi: https://doi.org/10.1177/10690727211026183

10. Smit R., Robin N., De Tofo C., Atanasova S. Industry-School Projects as an Aim to Foster Secondary School Students' Interest in Technology and Engineering Careers. *International Journal of Technology and Design Education*. 2021;31:61–79. doi: https://doi.org/10.1007/s10798-019-09538-0

11. Archer L., Dawson E., DeWitt J., Seakins A., Wong B. "Science Capital": A Conceptual, Methodological, and Empirical Argument for Extending Bourdieusian Notions of Capital Beyond the Arts. *Journal of Research in Science Teaching*. 2015;52(7):922–948. doi: https://doi.org/10.1002/tea.21227

12. Kudenko I., Simarro C., Pintó R. Fostering European Students' STEM Vocational Choices. In: Hahl K., Juuti K., Lampiselkä J., Uitto A., Lavonen J. (eds) Cognitive and Affective Aspects in Science Education Research. Contributions from Science Education Research. Vol. 3. Cham, Springer; 2017. p. 323–338. doi: https://doi.org/10.1007/978-3-319-58685-4_24

13. Moote J., Archer L., DeWitt J., MacLeod E. Comparing Students' Engineering and Science Aspirations from Age 10 to 16: Investigating the Role of Gender, Ethnicity, Cultural Capital, and Attitudinal Factors. *Journal of Engineering Education*. 2020;109(1):34–51. doi: https://doi.org/10.1002/jee.20302

14. Gonsalves A.J., Cavalcante A.S., Sprowls E.D., Iacono H. "Anybody Can Do Science if They're Brave Enough": Understanding the Role of Science Capital in Science Majors' Identity Trajectories into and Through Postsecondary Science. *Journal of Research in Science Teaching*. 2021;58(8):1117–1151. doi: https://doi.org/10.1002/tea.21695

15. Fitzgerald A. Out in the Field: Examining the Role of School-Based Experiences in Preparing Primary Pre-Service Teachers as Confident and Competent Teachers of Science. *International Journal of Science Education Volume*. 2020;42(2):290–309. doi: https://doi.org/10.1080/09500693.2019.1710618

16. Kelley T.R., Knowles J.G., Holland J.D., Han J. Increasing High School Teachers Self-Efficacy for Integrated STEM Instruction through a Collaborative Community of Practice. *International Journal of STEM Education*. 2020;7:14. doi: https://doi.org/10.1186/s40594-020-00211-w

17. Kolesnikova E.M., Kudenko I.A. Interest in STEM Professions at School: Problems of Career Guidance. *Sociologicheskie issledovaniya*. 2020;(4):124–133. (In Russ., abstract in Eng.) doi: https://doi.org/10.31857/S013216250009117-1

18. Kolesnikova E.M., Kudenko I.A. Schoolchildren about STEM Professions: General and Gender Features of Ideas and Choice. *RUDN Journal of Sociology*. 2021;21(2):239–252. Available at: https://journals.rudn.ru/sociology/article/view/26814/19516 (accessed 15.10.2021). (In Russ., abstract in Eng.)

19. Ashin G.K. [Elite Education]. *Obshchestvennye nauki i sovremennost'*. 2001;(5):82–99. (In Russ.)
20. Deich B.A., Galeeva N.V. The Historical Development of Out-of-School Education in Light of the Subculture of Childhood. *Russian Education and Society*. 2018;60(3):203–215. doi: https://doi.org/10.1080/10609393.2018.1451199
21. Saidov Z.A., Yarychev N.U. Approaches to the Modernization of the Content and Methods of Teaching in the Russian Education System in the Context of the Functioning of Post Industrial Society. *Problemy sovremennogo pedagogicheskogo obrazovaniya*. 2021;(70-4):312–315. Available at: https://cyberleninka.ru/article/n/podhody-k-modernizatsii-soderzhaniya-i-metodov-obucheniya-v-rossiyskoy-sisteme-obrazovaniya-v-usloviyah-funktsionirovaniya/viewer (accessed 15.10.2021). (In Russ., abstract in Eng.)
22. Graus G., Kosaretsky S.G., Kudryavtseva A.A., Polivanova K.N., Sivak E.V., Ivanov I.Yu. Edutainment Centers as an Educational Phenomenon. The Case of KidZania. *Educational Studies Moscow*. 2021;(2):243–260. doi: https://doi.org/10.17323/1814-9545-2021-2-243-260
23. Kiryanov A.E., Maslov D.V., Masyuk N.N., Kirillov A.A. Quantorium Reality: Training Young People for the Digital Economy. *Innovations*. 2020;(2):56–67. Available at: https://maginnov.ru/assets/files/volumes/2020.02/realnost-kvantoriuma-podgotovka-molodyh-kadrov-dlya-cifrovoj-ekonomiki.pdf (accessed 15.10.2021). (In Russ., abstract in Eng.)
24. Popov A.A., Glukhov P.P., Ishmatov Ya.A. Accessibility of Extracurricular Education in Russia: Assessment of Beneficiaries and the Regional Situation. *Tomsk State Pedagogical University Bulletin*. 2020;(6):67–83. (In Russ., abstract in Eng.) doi: http://doi.org/10.23951/1609-624X-2020-6-67-83
25. Baiborodova L.V. Availability of Supplementary Education for Children in Rural Areas: Problems and Their Solutions. *Obrazovatel'naya panorama*. 2018;(1):28–33. Available at: http://www.iro.yar.ru/fileadmin/iro/rio/op/op9/5_OP_2018_1_Baiborodova.pdf (accessed 15.11.2021). (In Russ., abstract in Eng.)
26. Krotova A.A. Analysis of Changes in the Additional Education of Children for the Period from 2015 to 2018. *MCU Journal of Pedagogy and Psychology*. 2020;(1):118–129. Available at: https://pedpsyjournal.mgpu.ru/2020/04/17/analiz-izmenenij-dopolnitelnogo-obrazovaniya-detej-za-period-2015-2018-godov (accessed 15.11.2021). (In Russ., abstract in Eng.)
27. Kersha Yu.D. Socio-Economic Composition of the School as a Factor of Reproduction of Inequality in Education. *Educational Studies Moscow*. 2020;(4):85–112. doi: http://doi.org/10.17323/1814-9545-2020-4-85-112
28. Kasyanova T.I., Maltsev A.V., Shkurin D.V. Professional Self-Determination of High School Students as a Social Problem. *The Education and Science Journal*. 2018;20(7):168–187. (In Russ., abstract in Eng.) doi: https://doi.org/10.17853/1994-5639-2018-7-168-187
29. Kosaretsky S.G., Kupriyanov B.V., Filippova D.S. Features of Children's Participation in Extracurricular Education Due to Differences in the Cultural, Educational and Property Status of the Family and Place of Residence. *Educational Studies Moscow*. 2016;(1):168–190. (In Russ., abstract in Eng.) doi: https://doi.org/10.17323/1814-9545-2016-1-168-190

Submitted 02.11.2021; approved after reviewing 17.01.2022; accepted for publication 26.01.2022.

About the authors:
Elena M. Kolesnikova, Senior Researcher, Institute of Sociology – Branch of the Federal Center of Theoretical and Applied Sociology of the Russian Academy of Sciences (bld. 5, 24/35 Krzhizhanovskiy St., Moscow 117218, Russian Federation), Cand.Sci. (Sociol.), **ORCID: https://orcid.org/0000-0003-2174-2524**, kolesnikova@mail.ru
Irina A. Kudenko, Principal Evaluator, Kudenko Consulting Ltd. – Global Evaluation and Research Services (16-18 Duke Street, Berkshire RG1 4RU, UK), Cand.Sci. (Geography), **ORCID: https://orcid.org/0000-0003-2110-8806**, ikudenko@educationdevelopmenttrust.com

Contribution of the authors:
E. M. Kolesnikova – implementation of the part of the project presented in the article; justification of the concept of the article; literature review; preparation of the article; critical analysis of the text; analysis of the literature on the stated problem; participation in processing the results of the research; structuring the text of the article; generation of the conceptual idea and methodology.
I. A. Kudenko – justification of article concept; literature review; preparation of article text version; critical analysis of text; analysis of literature on stated problem; participation in processing of research results; structuring of article text; generation of conceptual idea and methodology; data curation.

All authors have read and approved the final manuscript.

СПИСОК
ИСПОЛЬЗОВАННЫХ ИСТОЧНИКОВ

1. Grinis I. The STEM Requirements of "Non-STEM" Jobs: Evidence from UK Online Vacancy Postings // Economics of Education Review. 2019. Vol. 70. P. 144–158. doi: https://doi.org/10.1016/j.econedurev.2019.02.005
2. Ахапкин Н. Ю., Волкова Н. Н., Иванов А. Е. Развитие цифровой экономики и перспективы трансформации российского рынка труда // Вестник ИЭ РАН. 2018. № 5. С. 51–65. URL: https://inecon.org/images/stories/publicacii/vesnik-ran/2018/VIE_RAS_5_2018.pdf (дата обращения: 15.10.2021).
3. Disruptive Moments as Opportunities towards Justice-Oriented Pedagogical Practice in Informal Science Learning / A. C. Barton [et al.] // Science Education. 2021. Vol. 105, issue 6. P. 1229–1251. doi: https://doi.org/10.1002/sce.21682
4. Cooper G., Berry A. Demographic Predictors of Senior Secondary Participation in Biology, Physics, Chemistry and Earth/Space Sciences: Students' Access to Cultural, Social and Science Capital // International Journal of Science Education. 2020. Vol. 42, issue 1. P. 151–166. doi: https://doi.org/10.1080/09500693.2019.1708510
5. Godec S., Archer L., Dawson E. Interested but Not Being Served: Mapping Young People's Participation in Informal STEM Education through an Equity Lens // Research Papers in Education. 2022. Vol. 37, issue 2. P. 221–248. doi: https://doi.org/10.1080/02671522.2020.1849365
6. Understanding the Conditions Informing Successful STEM Clubs: What Does the Evidence Base Tell Us? / K. Davis [et al.] // Studies in Science Education. 2021. doi: https://doi.org/10.1080/03057267.2021.1969168
7. Secondary Students' Access to Careers Information: The Role of Socio-Economic Background / A. M. Dockery [et al.] // Australian Educational Researcher. 2021. doi: http://doi.org/10.1007/s13384-021-00469-1
8. Dodd V., Hanson J., Hooley T. Increasing Students' Career Readiness Through Career Guidance: Measuring the Impact with a Validated Measure // British Journal of Guidance & Counselling. 2022. Vol. 50, issue 2. P. 260–272. doi: https://doi.org/10.1080/03069885.2021.1937515
9. Dream Jobs and Employment Realities: How Adolescents' Career Aspirations Compare to Labor Demands and Automation Risks / K. A. Hoff [et al.] // Journal of Career Assessment. 2022. Vol. 30, issue 1. P. 134–156. doi: https://doi.org/10.1177/10690727211026183
10. Industry-School Projects as an Aim to Foster Secondary School Students' Interest in Technology and Engineering Careers / R. Smit [et al.] // International Journal of Technology and Design Education. 2021. Vol. 31. P. 61–79. doi: https://doi.org/10.1007/s10798-019-09538-0
11. "Science Capital": A Conceptual, Methodological, and Empirical Argument for Extending Bourdieusian Notions of Capital Beyond the Arts / L. Archer [et al.] // Journal of Research in Science Teaching. 2015. Vol. 52, issue 7. P. 922–948. doi: https://doi.org/10.1002/tea.21227
12. Kudenko I., Simarro C., Pintó R. Fostering European Students' STEM Vocational Choices // Cognitive and Affective Aspects in Science Education Research. Contributions from Science Education Research ; K. Hahl [et al.] (eds). Vol. 3. Springer, Cham, 2017. P. 323–338. doi: https://doi.org/10.1007/978-3-319-58685-4_24
13. Comparing Students' Engineering and Science Aspirations from age 10 to 16: Investigating the Role of Gender, Ethnicity, Cultural Capital, and Attitudinal Factors / J. Moote [et al.] // Journal of Engineering Education. 2020. Vol. 109, issue 1. P. 34–51. doi: https://doi.org/10.1002/jee.20302
14. "Anybody Can Do Science if They're Brave Enough": Understanding the Role of Science Capital in Science Majors' Identity Trajectories into and Through Postsecondary Science / A. J. Gonsalves [et al.] // Journal of Research in Science Teaching. 2021. Vol. 58, issue 8. P. 1117–1151. doi: https://doi.org/10.1002/tea.21695
15. Fitzgerald A. Out in the Field: Examining the Role of School-Based Experiences in Preparing Primary Pre-Service Teachers as Confident and Competent Teachers of Science // International Journal of Science Education Volume. 2020. Vol. 42, issue 2. P. 290–309. doi: https://doi.org/10.1080/09500693.2019.1710618
16. Increasing High School Teachers Self-Efficacy for Integrated STEM Instruction through a Collaborative Community of Practice / T. R. Kelley [et al.] // International Journal of STEM Education. 2020. Vol. 7. doi: https://doi.org/10.1186/s40594-020-00211-w
17. Колесникова Е. М., Куденко И. А Интерес к STEM-профессиям в школе: проблемы профориентации // Социологические исследования. 2020. № 4. С. 124–133. doi: https://doi.org/10.31857/S013216250009117-1
18. Колесникова Е. М., Куденко И. А Школьники о STEM-профессиях: общие и гендерные особенности представлений // Вестник Российского университета дружбы народов. Серия: Социология. 2021. Т. 21, № 2. С. 239–252. URL: https://journals.rudn.ru/sociology/article/view/26814/19516 (дата обращения: 15.10.2021).
19. Ашин Г. К. Элитное образование // Общественные науки и современность. 2001. № 5. С. 82–99.
20. Deich B. A., Galeeva N. V. The Historical Development of Out-of-School Education in Light of the Subculture of Childhood // Russian Education and Society. 2018. Vol. 60, issue 3. P. 203–215. doi: https://doi.org/10.1080/10609393.2018.1451199

21. Саидов З. А., Ярычев Н. У. Подходы к модернизации содержания и методов обучения в Российской системе образования в условиях функционирования постиндустриального общества // Проблемы современного педагогического образования. 2021. № 70-4. С. 312–315. URL. https://cyberleninka.ru/article/n/podhody-k-modernizatsii-soderzhaniya-i-metodov-obucheniya-v-rossiyskoy-sisteme-obrazovaniya-v-usloviyah-funktsionirovaniya/viewer (дата обращения: 15.10.2021).

22. Эдьютейнмент-центры как образовательный феномен. Кейс Кидзании / Г. Граус [и др.] // Вопросы образования. 2021. № 2. С. 243–260. doi: http://doi.org/10.17323/1814-9545-2021-2-243-260

23. Реальность Кванториума: подготовка молодых кадров для цифровой экономики / А. Е. Кирьянов [и др.] // Инновации. 2020. № 2 (256). С. 56–67. URL: https://maginnov.ru/assets/files/volumes/2020.02/realnost-kvantoriuma-podgotovka-molodyh-kadrov-dlya-cifrovoj-ekonomiki.pdf (дата обращения: 15.10.2021).

24. Попов А. А., Глухов П. П., Ешматов Я. А. Доступность дополнительного образования в России: оценка благополучателей и региональная ситуация // Вестник Томского государственного педагогического университета. 2020. Вып. 6 (212). С. 67–83. doi: http://doi.org/10.23951/1609-624X-2020-6-67-83

25. Байбородова Л. В. Доступность дополнительного образования детей на селе: проблемы и пути их решения // Образовательная панорама. 2018. № 1 (9). С. 28–33. URL: http://www.iro.yar.ru/fileadmin/iro/rio/op/op9/5_OP_2018_1_Baiborodova.pdf (дата обращения: 15.10.2021).

26. Кротова А. А. Анализ изменений дополнительного образования детей за период 2015–2018 годов // Вестник Московского городского педагогического университета. Серия: Педагогика и психология. 2020. № 1 (51). С. 118–129. URL: https://pedpsyjournal.mgpu.ru/2020/04/17/analiz-izmenenij-dopolnitelnogo-obrazovaniya-detej-za-period-2015-2018-godov (дата обращения: 15.10.2021).

27. Керша Ю. Д. Социально-экономическая композиция школы как фактор воспроизводства неравенства в образовании // Вопросы образования. 2020. № 4. С. 85–112. doi: http://doi.org/10.17323/1814-9545-2020-4-85-112

28. Касьянова Т. И., Мальцев А. В., Шкурин Д. В. Профессиональное самоопределение старшеклассников как общественная проблема // Образование и наука. 2018. Т. 20, № 7. С. 168–187. doi: https://doi.org/10.17853/1994-5639-2018-7-168-187

29. Косарецкий С. Г., Куприянов Б. В., Филиппова Д. С. Особенности участия детей в дополнительном образовании, обусловленные различиями в культурно-образовательном и имущественном статусе семьи и месте проживания // Вопросы образования. 2016. № 1. С. 168–190. doi: http://doi.org/10.17323/1814-9545-2016-1-168-190

Поступила 02.11.2021; одобрена после рецензирования 17.01.2022; принята к публикации 26.01.2022.

Об авторах:

Колесникова Елена Михайловна, старший научный сотрудник Института социологии Федерального научно-исследовательского социологического центра Российской академии наук (117218, Российская Федерация, г. Москва, ул. Кржижановского, д. 24/35, корп. 5), кандидат социологических наук, **ORCID: https://orcid.org/0000-0003-2174-2524**, kolesnikova@mail.ru

Куденко Ирина Александровна, главный эксперт Куденко консалтинг – глобальные услуги по оценке и исследованиям (RG1 4RU, Великобритания, г. Беркшир, Дьюк-стрит, д. 16–18), кандидат географических наук, **ORCID: https://orcid.org/0000-0003-2110-8806**, ikudenko@educationdevelopmenttrust.com

Заявленный вклад авторов:

Е. М. Колесникова – реализация части проекта, представленной в статье; обоснование концепции статьи; обзор литературы; подготовка текстовой версии статьи; критический анализ текста; анализ литературы по заявленной проблеме; участие в обработке результатов исследования; структурирование текста статьи; генерация концептуальной идеи и методологии.

И. А. Куденко – обоснование концепции статьи; обзор литературы; подготовка текстовой версии статьи; критический анализ текста; анализ литературы по заявленной проблеме; участие в обработке результатов исследования; структурирование текста статьи; генерация концептуальной идеи и методологии; курирование данных.

Все авторы прочитали и одобрили окончательный вариант рукописи.