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Comparative study of socio-economic barriers to development of digital competences during formation of human capital in Russian Arctic

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Abstract. The article is dedicated to analysis of problems and barriers hindering the development of human capital in the Arctic region, starting from the stage when skills and abilities, in particular those connected to digital competences and information and communication technologies, are acquired by future professionals throughout modern higher education. We have presented the results for a target group comprising students of the Murmansk Arctic State University (Apatity Branch). We have carried out a survey of the target group, including via the online GoogleForms service, analyzing the answers given by the respondents. Analysis of the results allowed to identify the socio-economic barriers hindering the development of digital competences. We have provided the results of comparative analysis with the previously obtained characteristics of students of Peter the Great St. Petersburg Polytechnic University, finding both similarities and differences in certain aspects of formation of digital competences of the respondents of the two given regions.

1. Introduction

The Arctic Zone of the Russian Federation is an extraordinary region with great potential and vast reserves of unique natural resources. However, further progress, exploration and development of the Arctic territories primarily depends on the human resources available in the northern regions and on the quality of these resources. Human capital can serve as a tool for assessing the quality and proficiency of human resources. The current stage of socio-economic development of society accompanied by digitalization of all spheres of human activity imposes new demands on human capital, which becomes increasingly dependent, among other factors, on modern digital competences of employees of enterprises, organizations and public institutions. However, both Russian and international experience indicates that modern human resources have insufficiently mastered the digital competences, and there are certain social and economic problems in this sphere [1].

It is widely known that both basic and professional digital competences, as well as skills in applying modern information and communication technologies (ICT) are gained throughout higher education; accordingly, this is also when future professionals first encounter barriers to applying these skills and competences in the digital economy. For this reason, poorly developed digital competences in human resources of the North is a problem that should be approached by studying the educational



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process in the region's universities, identifying barriers and finding methods to overcome them based on the experience of other Russian regions.

Thus, this paper reports on the results of studying socio-economic barriers hindering the progress of digital competences for human resources in the Arctic at the stage of skill formation throughout higher education, using the example of the Murmansk Arctic State University (branch in the town of Apatity); furthermore, we have carried out comparative analysis with the characteristics of students of the Peter the Great St. Petersburg Polytechnic University.

The following tasks have been completed to achieve this goal:

- study the composition and structure of digital competences of a modern professional, assessing individual human capital;
- compile a list of modern tools used for conducting surveys of target groups;
- develop a questionnaire, including an online version, allowing to obtain the results required in easily accessible form;
- carry out a survey of target group representatives who are students of the Murmansk State University (Apatity Branch) and Peter the Great St. Petersburg Polytechnic University;
- carry out comparative analysis of the results obtained in the survey in order to identify the socio-economic barriers preventing the students from gaining digital competences, depending on the geographical distribution of respondents;
- develop recommendations for solving problems and eliminating the barriers detected.

2. Regional aspect in formation of digital competences

The concept of digital culture introduced in early 21st century in [2] and [3] was soon expanded in sociology and cultural studies.

When it comes to issues of socio-economic development of the Arctic territories, the focus is typically on general issues [4] of achieving sustainable development of the Arctic, problems of ensuring environmental safety of specific territories [5], analyzing the consequences of human activity on the Arctic environment [6] and adapting the territorial development strategy [7].

Issues concerning the effect that the human factor has on the development of the Arctic [8] are also considered. However, the influence of digital culture on the socio-economic aspects of development of territories requires further in-depth study.

For this reason, we believe that it is important to consider digital culture and the formation of digital competences of individuals and digital culture taking into account the effect of regional factors. This is extremely important for working out a strategy for development of the Arctic territories, since the intensity and rate of its industrial development largely depends on the opportunities for applying innovative digital technologies. At the same time, using digital technologies for development of territories means that the region's human capital should be sufficiently advanced, with digital competences available within the population.

Digital competence of individuals is traditionally understood as their ability to effectively and safely use information and communication technologies in the process of learning and in professional activities. Participating in the life of the society using new opportunities of digital economy enhances social integration of employees. According to the [9], a significant part of the planet's population is excluded from this process.

The digital competences of individuals comprise the overall digital culture of the region. This calls for analysis as to whether the digital competences of the region's population correspond to the needs and objectives formulated in the regional development strategies and the Strategy for Development of the Arctic zone of the Russian Federation as a whole. However, no such studies have been carried out in Russia so far. The effect of the geographical factor on the barriers to development of digital culture is discussed in [10,11].

Some studies, in particular [12], were dedicated to the issues concerning the digital competences of students as a social group that is the most mobile, motivated and receptive to new information.

A noteworthy foreign study [13] was aimed at analyzing the actual state of digital culture of students in view of their competences in using modern technologies to distribute information. A significant number of studies considered student motivation for using digital technologies. The key factors, according to [14], include the need to acquire knowledge, the age of students, and their loyalty to using digital technologies. Other studies, for example, [14, 15], focused on gender aspects of using digital technologies but the results were inconclusive.

Notably, different groups of population can benefit from modern digital technologies to a considerably different extent, largely depending on initial digital skills in learning [17, 18]. Difference in digital skills subsequently generates digital barriers preventing professionals from fully using existing digital technologies or learning new ones. Digital barriers also reduce the opportunities and availability of further education. Studies typically differentiate between barriers of the first (access to digital technologies) and second (differences in usage skills) levels [17]. It was established in [13] that what can be called a digital barrier of the third level has now evolved (judging from considerably different results of using the Internet). We should note that the digital barrier of the third level is currently poorly understood in foreign literature; generally, studies consider socio-demographic and socio-economic factors forming this type of barrier.

Moreover, digital barriers exist both between individual countries and within them, including even countries that are successful in terms of digital development, such as Finland (in accordance with the level of education of its population) [19]. It was proposed in [15] to start with improving the digital skills of groups with different starting positions up to a certain level before actively encouraging use of Internet technologies among these groups.

3. Methodology

The methodology of the study is based both on general classical scientific methods, such as systemic, comparative and content analysis, and on a specific methodology for conducting surveys in target groups described in [20]. This methodology involves the following sequence of stages: (1) formulating the goal of the study; (2) identifying target groups, in our case, students of the Institute of Industrial Management, Economics and Trade of Peter the Great St. Petersburg Polytechnic University (SPbPU) and of the Apatity Branch of the Murmansk Arctic State University (MASU); (3) devising a questionnaire comprising 4 sections and 21 questions, publishing the online version of the questionnaire via GoogleForms; (4) interviewing representatives of target groups (67 students in St. Petersburg and 74 students in Apatity); (5) carrying out comparative analysis of the results obtained, particularly based on geographical distribution of respondents. The total number of respondents was 174.

4. Results of the study

Courses in areas relevant to the enterprises of the Kola Peninsula are available at MASU in Apatity: natural sciences are represented by Geology and Biology, social sciences by Economics, Sociology and Tourism, and technical disciplines by Information systems and Technologies, Power Engineering and Electrical Engineering, Mining, and Technical Physics. The branch offers bachelor's, master's and specialist degrees.

The sample of respondents reflects the ratio of students in different courses: 57.53% study social sciences and 42.47% natural sciences and technical disciplines. Among those surveyed, 46.6% are 1st and 2nd year bachelor's students, 47.9% are 3rd and 4th year bachelor's students, and 5.5% are master's students.

The sample of students of Peter the Great St. Petersburg Polytechnic University was constructed similarly.

As the students' curricula and training programs differed, we focused on analyzing the differences in their assessment of the relevance and importance of digital competences.

Analyzing the attractiveness of self-study, we have found (Table 1) that while self-study was the option predominantly chosen by all groups of MASU students, a noticeable proportion of students in

the natural sciences and technical disciplines groups either gave low priority to self-study (Nos. 2 and 3) or had reservations about it (No. 6). The proportion of students completely rejecting self-study was lower for the social sciences group but the proportion of students finding self-study inconvenient was significantly higher. Self-study obviously cannot provide the fairly advanced technological aids and facilities required for studying technical disciplines; the form of studies chosen in social sciences, on the other hand, depends on the quality of teaching available.

The students of SPbPU felt more conservative about self-study than the students of MASU.

Table 1. Attractiveness of self-study, %

No.	Questions	MASU			SPbPU
		Natural sciences & technical disciplines	Social sciences	Overall	
1	I do self-study often, it is very convenient	35.48	38.10	36.99	29.85
2	I do self-study if there are no other options	32.26	21.43	26.03	31.34
3	I do self-study rarely, it is not very convenient	6.45	19.05	13.70	13.9
4	I have had a negative experience, I do not do self-study anymore	3.23	0	1.37	1.4
5	I have not yet done self-study but I plan to	3.23	9.52	6.85	9.7
6	I did not do self-study and do not plan to	19.35	11.90	15.07	16.7

Different types of educational materials (Table 2) were assessed for their attractiveness and convenience for using in self-study (on a scale from 1, for inconvenient, to 5, the most convenient); apparently, students in natural sciences and technical disciplines ranked paper and electronic courses almost equally. Students in social sciences exhibited diametrically opposed preferences, ranking video courses as the most and paper textbooks as the least convenient type of material. Notice that these scores are generally lower than those obtained in a similar study at SPbPU, where students preferred traditional forms of educational materials. In our opinion, one of the reasons for this is the geographical factor, and, consequently, the cost: acquiring modern professional competences in the Arctic is impossible without up-to-date sources of information, and electronic materials prove to be the most accessible and cheap.

Table 2. Assessment of attractiveness and convenience for using in self-study, score

No.	Type	MASU			SPbPU
		Natural sciences & technical disciplines	Social sciences	Overall	
1	Paper textbook (study guide)	3.87	3.69	3.55	4.24
2	E-textbook (electronic study guide)	3.81	3.81	3.81	4.01
3	Video course	3.39	3.98	3.72	3.63

Comparative analysis of use of educational platforms (Table 3) confirmed that bachelor's students mainly use Russian platforms such as Open Education and Lectorium, recommended to them by university teachers in the course of studies. A disconcertingly high proportion of MASU (over 45%) do not use any educational platforms.

Table 3. Assessment of attractiveness and convenience for using in self-study, %

No.	Source	MASU			SPbPU
		Natural sciences & technical disciplines	Social sciences	Overall	
1	Coursera	6.45	2.38	4.2	23.88
2	Edx	0	0	0	7.46
3	Landwings	3.23	4.76	4.2	1.49
4	Uniweb	3.23	4.76	4.2	7.46
5	Zillion	0	0	0	1.49
6	Web.University	6.45	16.67	12.5	22.39
7	Lectorium	3.23	11.90	8.3	14.93
8	Open education	25.81	21.43	23.6	62.69
9	Universarium	0	4.76	2.8	10.45
10	Other	12.9	26.19	22.2	2.99
11	Not using any platforms	48.39	36.71	45.8	8.96

Notably, all students are reasonably certain that the university should provide access to all the materials necessary for research (45.8% at MASU and 58.46% at SPbPU). The reason for these high social expectations is that supplying students with educational materials is currently standard practice. However, while students at SPbPU are practically not concerned with financial matters, the financial barrier is very pronounced for students of the Arctic region: a third of the respondents remarked on the high cost of the necessary materials (Table 4).

Table 4. Willingness of students to independently pay for materials necessary for education and research, %

No.	Answers	MASU			SPbPU
		Natural sciences & technical disciplines	Social sciences	Overall	
1	Yes, I am willing to pay myself	12.9	9.52	12.5	16.92
2	No, the university should provide access to the materials	48.39	42.86	45.8	58.46
3	No, I can always find open-access materials	32.26	47.62	41.7	24.62
4	No, this is too expensive	25.81	28.57	30.6	4.62

Although students state that they are willing to pay for access to the materials necessary for education, in practice, 95% of students are not ready to bear such expenses; the results are identical in all groups of respondents.

Students of both universities believe that face-to-face communication with a teacher is necessary, mainly in practical classes (76.70% for MASU, 85.07% for SPbPU), and, to a lesser extent, in lectures (57.5% and 34.33%, respectively). Students prefer to bring up any questions to the teacher either personally (score of 3.33 points on a scale from 0, for not at all, to 4, for almost always) or by e-mail (2.14 points for MASU, 3.19 points for SPbPU). MASU students using social networking services to communicate prefer VKontakte (80.6%). The percentage of students using VKontakte is also high for SPbPU (56.72%), 22.39% prefer Google+, while 23.88% do not use any social networks to communicate with teachers. Furthermore, 69.4% of respondents at MASU do not use instant

messengers to communicate with teachers, while the proportion of such students is 31.34% at SPbPU, with almost half (46.27%) using WhatsApp for this purpose.

Table 5. Availability of electronic resources, %

No.	Answers	MASU	SPbPU
1	Round the clock access (no time limit)	84.9	59.70
2	Access for limited time (but from any location)	13.7	22.39
3	Access at university only	1.4	14.93
4	Access is very difficult (only accidental access)	0	2.99

Assessing the availability of electronic resources (Table 5), we have discovered an interesting pattern: 84.9% of students from the Arctic region report that they have unlimited 24-hour access, while only 59.70% of St. Petersburg students report so, with the rest experiencing difficulties with access to some extent.

In most cases, students report that they began to actively use Internet resources in upper grades of school (61.6% for MASU and 64.18% for SPbPU), which makes using online resources interesting and easy for them (this is reported by 67.1% and 61.19%, respectively).

As we have established, financial matters are one of the most considerable barriers hindering access to electronic resources (Tables 6 and 7).

Table 6. Financial barriers limiting access, %

No.	Answers	MASU	SPbPU
1	Yes	26.0	34.85
2	Not	17.8	19.70
3	Partly	56.2	45.45

Table 7. Assessment of barriers to access, score

No.	Answers	MASU	SPbPU
1	Hard to use (need special knowledge and skills)	0.78	1.00
2	Hard to access	1.36	1.63
3	Inconvenient (not user-friendly)	1.04	1.82
4	Expensive	1.80	1.91
5	See no reason to	0.89	1.17
6	Other (specify)	0.84	0.37

Students mention difficulties with access and with using electronic resources (i.e., they are not user-friendly) as other important barriers. We should note that analysis of the answers given by the respondents showed that students who were unwilling to use digital technologies for studies gave high scores to existing barriers, while students actively involved in online studies (either independently or on recommendation of teachers) assessed those barriers as insignificant.

5. Conclusions and discussion

To summarize, we have compiled a questionnaire and conducted a survey of target groups, including via the online GoogleForms service; analyzing the data from respondents, we have obtained the following main results:

- a substantial proportion of students (about 30% of respondents) feel rather conservative about acquiring new professional digital competences;
- barriers hindering the development of digital competences depend on three groups of factors: geographical/regional, socio-economic and personal;
- financial barriers are one of the most substantial factors hindering the development of digital competences;

- comparative analysis of the differences in the views and approaches of the two geographically distributed groups of respondents (in St. Petersburg and in Apatity) revealed that the overall scenarios by which students of SPbPU and MASU use digital technologies and ICT differ only insignificantly; a possible explanation for this is that the respondents all belong to the same generation, growing up during the era of the Internet with modern means of communication widely available to schoolchildren starting from the upper grades. Besides, all respondents come from approximately the same socio-economic group with access to Internet resources.

However, some of the answers the respondents gave differed; those primarily concerned the availability of electronic resources. Compared to students of the Polytechnic University, students of the Murmansk Arctic State University (Apatity Branch) have better access to the Internet, i.e., it is available around the clock and without time limits. Students' views on the role of teachers also differ: for example, the number of St. Petersburg students expecting to communicate with teachers face-to-face and preferring this channel of communication during lectures is almost twice that number in Apatity.

A contentious issue in this study is that we did not take into account whether the students resided on campus or at home. Students living with their parents typically have better access to high-speed Internet, while only separate Wi-Fi zones with limited coverage are available to students living on campus at the Polytechnic University.

Directions for further studies are in expanding the sample by increasing the number of respondents, and in including respondents from other universities and regions of Russia, as well as from other countries.

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