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The Scientific Enlightenment System in Russia in the Early Twentieth Century as a Model for Popularizing Science

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ABSTRACT

This research reconstructs the traditions of scientific enlightenment in Russia. The turn of the nineteenth and twentieth centuries was chosen as the most representative period. The modern age saw the establishment of the optimal model for advancing science in the global context and its crucial segment – Russian science. This period was characterized by significant scientific and sociopolitical changes. The level of education in Russia was extremely low; good education was accessible only to the upper class. Therefore, a program for popularizing science was launched. This research investigates the means and methods that were used to popularize science in Russia. In order to achieve the set goal, a set of complementary methods was used, including analysis, didactic method, and structural-functional analysis. The research also generalizes the experience of Russian and foreign experts in the subject at hand and applies the principles of historicism, systematicity, and dialectic unity of the historical and the logical. The main means of popularization of science were as follows: publication of popular-science periodicals, granting of considerable autonomy to higher educational institutions, and establishment of out-of-school institutions. During the soviet period, the popularization of science continued, but in the light of Marxism-Leninism, which included the launch of a state program for eliminating illiteracy.

KEYWORDS
Traditions of science popularization; scientific enlightenment; popular-science press; modern culture; development of science.

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Introduction

The life-changing era of the early twentieth century featured a scientific and technological breakthrough that affected not only the global landscape, but also the daily life of people. Albert Einstein's theory of relativity on the one hand and Sigmund Freud's psychoanalysis on the other hand transformed the understanding of both the physical world and the socio-psychological nature of the human being. The progress of civilization accelerated the pace of life rapidly. The capital of the Russian Empire became a true megalopolis: it was illuminated with electric lights according to the technique invented by electrical engineer

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Pavel Yablochkov. The nobility in St. Petersburg moved to automobiles, while common people began riding trams (Daly, 2014). Telephones, telegraphs, and radiotelegraphs (radios) of Alexander Popov (the first trial whereof took place in 1895 at the meeting of the Physics Department of the Russian Physics and Chemistry Society at St. Petersburg University) provided timely communication (Muravyeva, 2004; Kappeler, 2014). In the West, Guglielmo Marconi is considered the inventor of the radio, since his transatlantic transmission turned out to be significantly more commercialized, despite the fact that Popov's and Marconi's wireless transmission experiments were conducted in parallel.

Popularization of science is one of the main means to familiarize the general public with scientific activities (Dagnino & Lima, 2016). History shows that the countries that had cutting-edge technologies at their disposal became geopolitical leaders. In the late nineteenth and early twentieth centuries, the Russian Empire was a large colonial country; however, the level of education among the population lagged significantly behind that of the developed European states (Chamberlin, 2014; Wirtschafter, 2015). Therefore, Russia launched a large-scale campaign to popularize science, which resulted in Russian experts being considered some of the best ones during the soviet period.

The effect that science had on the minds was huge. The specific flair of the modern era, notable for its panestheticism and god seeking, formed a special approach to scientific knowledge. Members of various intellectual elites sought to provide scientific reasoning for the spiritual domain and esthetic activities (Kusber, 2014; Daly, 2014; Rogaeva, 2015). Such was the anthroposophical teaching of Rudolf Steiner, which he termed "spiritual science", which found resonance in both Europe and Russia. In journalism, this trend manifested in the emergence of such magazines as "The Occult Science Bulletin" (1907), which considered themselves popular-science ones. However, it is worth noting that this direction did not help in popularizing science, since such magazines addressed superstitions, which had nothing to do with scientific activities. Science was interpreted as the "World of God" (1892-1906), which was also the name of one of the most prominent Russian literary and popular-science magazines of the early twentieth century, which was intended for self-education. The scientific and technological progress, urbanism, and the new concept of the human being, who came from the world of nature and lived in "concrete jungles" became the worldview foundation for the establishment of avant-garde "future art" movements (futurism, cubism, abstractionism, and, later, constructivism) that were important for Russia. Outstanding cultural figures took active part in the preparation of popular-science periodicals.

At the turn of the nineteenth and twentieth centuries, enlightenment initiatives targeted at various social strata became common (Ivanov, 1999; Kusber, 2014; Rogaeva, 2015). At that time, the main organizers of cultural and enlightenment activities were patrons of different social status, who established workers' enlightenment societies, people's universities, and people's houses (for instance, the famous Sofia Panina People's House, located in the deprived Ligovsky suburbs of St. Petersburg). The development of out-of-school establishments as an independent institution began in the early twentieth

century. For instance, the "Daytime Orphanage" and, later, the famous "Settlement" society was established at the premises of a special children's club in Moscow in 1905 (Muravyeva, 2004; Rogaeva, 2015; Von Haxthausen, 2013). The name of the society referred to the American practice of missionary settlements intended for enlightenment work.

Many Russian intellectuals (professors, pedagogues, lawyers, doctors, etc.) took active part in such enlightenment activities, thus realizing the moral and ethical concept of "the intelligentsia's duty to the people" (Apokov, 2012; Ivanov, 1999; Bailes, 2015). A somewhat different approach to enlightenment and popularization of science was established in the soviet times (more precisely, in the second half of the twentieth century), when outstanding soviet scientists participated in the work of an extensive network of various scientific societies and associations (for instance, the "Znanie" (Knowledge) society).

By investigating the popularization of science in the nineteenth and twentieth centuries, it is possible to assess the cultural and educational level of the country's population during that period.

Aim of the Study

This study aims to investigate the popularization of science in Russia in the late nineteenth and early twentieth centuries.

Research questions

What methods were used to popularize scientific activities?

Method

This study used a set of methods relevant to the set aim, including systems analysis, dialectic method, conceptual, structural-semiotic, and structural-functional analysis, which allow investigating science as a holistic system that is based on the human need to order the elements of the surrounding world and one's own actions therein. The study also generalized the experience of Russian and foreign experts on the subject at hand.

The study used the principles of historicism, systematicity, unity of the historical and the logical, and abstract to concrete thinking.

Data, Analysis, and Results

In the late nineteenth and early twentieth centuries, Russian science not only contributed to the worldwide scientific thought, but was also the driving force of progress.

In the late 1930s, Nobel laureate Pyotr Kapitsa (1894 – 1984) in his letter to Stalin directly related the level of scientific development to the scientific propaganda, emphasizing that "the masses have great natural interest" in science:

"Comrade Stalin,

Our situation with science is adverse. All the usual public statements that claim that the Soviet Union offers the best conditions for science is untrue.

These statements are not only bad because they are lies, but they are even worse because they do not allow getting the scientific life in the country up and running…

… In my opinion, the goal is straightforward: we need to foster mass interest in science and show its significance for progress. I do not think this is too difficult, since the masses have great natural interest… Capitalist countries pay much attention to scientific propaganda. Such work is especially widespread in England, which, in my opinion, largely explains… its exceptionally high level of science.

England established special societies to popularize science – the Royal Institution and the British Science Association – one hundred years ago. Its museums – the British Museum and the Kensington Museum – are the biggest ones in the world; its press pays more attention to science and scientific life than any other country does…

In the Soviet Union, the popularization of science is botched. England's example is quite illuminating…

I am certain that if we manage to interest the masses in science, then the scientific workers will become enthusiastic. They will become the pride of the country, they will be proud of Soviet science, they will organize it themselves…" (Apokov, 2012).

In this letter, Pyotr Kapitsa identified five main directions of scientific propaganda: scientific museums, movies, popular literature and lectures on scientific subjects, scientific journalism, and propaganda of science in schools. Conservatism, which is typical for the system of spread of scientific knowledge that intends to seal the elitist essence of science, had made it so that the main means of popularizing science have remained virtually unchanged since the beginning of the modern era. These include: 1) the press; 2) scientific debates; demonstrations, public lectures, defenses of theses; 3) scientific societies (the least accessible form); 4) museums; 5) educational system.

Ever since Peter I established the first scientific organization – the so-called "Petrovskaya Akademia" (Peter Academy) – Russian science was governed by the Academy of Sciences. In the early twentieth century, higher educational institutions became the leading scientific centers (Platonova et al., 2016). This became possible due to the fact that scientific schools were established therein. In general, the environment that stimulates scientific search is the defining factor in the expansion of scientific knowledge.

Progress in the development of scientific paradigms is closely related to the special atmosphere of universities. In Russia, "the idea of a university" (which was the title of classical works by John Henry Newman and Karl Jaspers on the phenomenology of universities) was associated with the issue regarding the autonomy of universities. Educational reforms conducted during the reign of Alexander I and Alexander II were followed by further steps taken in this direction in the early twentieth century. After the revolution of 1905, Russian universities became autonomous, i.e. were granted self-government. University autonomy included the right to choose academic programs independently;

positions at universities were elective (including that of rector, despite that fact that all previous versions of university statutes had this position as appointive); universities had their own courts, typographies, and censorship. In addition, various types of cultural and leisure activities began to develop in the general educational system in the early twentieth century. For instance, "scientific and literary student clubs, choirs and orchestras, which used to be banned, were now considered advantageous <…> The academic life of students saw the introduction of corporate representation, which used to be considered seditious. <…> The first Russian revolution radically altered the organizational forms, practice, and ideology of student associations. The major role was given to faculty, inter-faculty, and city coalitions of student self-government, which were established upon the initiative of the students themselves and elected at student meetings based on party lists. These organizations protected the academic, economic, and civil interests of students" (Ivanov, 1999).

The Russian system of secondary and higher education was based on the German model of education. However, unlike their Western European counterparts, Russian universities never were "states within states"; in other words, they were never separated from the public. Therefore, Russian universities were closely related to the establishment and development of the Russian press. For instance, in the early twentieth century, students published special scientific and journalistic digests. These are an understudied layer of early-twentieth-century press.

Students often attended lectures at other faculties and tried not to make their study utilitarian. In order to clarify the latter theses, which contradicts the current accepted standards, it is necessary to cite a lecture, delivered at a university by Russian chemist Dmitri Mendeleev:

"However, simply getting diplomas and getting acquainted with a subject is not why we are here and not why universities are established… there is another, higher aspect, … which grants university knowledge a tone that should be called the spirit of the university… This spirit consists solely and entirely in one thing: the aspiration to learn the truth, by any means – not practical benefits, not personal improvement… – all these things are secondary, they are appendages… Understanding the truth in all its purity and perfection – this is the only spirit of the university" (Muravyeva, 2004).

In addition to its larger-than-life Renaissance nature, the personality of Mendeleev was attractive because he was an idol for the studying youth, a public figure, and publicist. At the biggest higher educational institution in Russia – the Saint Petersburg Imperial University – one could listen to the lectures of physicist Ivan Borgman (1849 – 1914), who became the first person to be elected rector of the Saint Petersburg University in 1905, chemist Lev Chugaev (1873 – 1922), zoologist Valentin Dogiel (1882 – 1955), linguist Jan Baudouin de Courtenay (1845 – 1929), and philologist Alexey Shakhmatov (1864 – 1920). Students of the historical and philological faculty were especially keen on the "Pushkin Seminar", held by Semyon Vengerov (1855 – 1920). A firm believer in the cultural-historical method, which was dominant at that time, Vengerov educated a series of brilliant cultural figures and philologists. The

latter managed to establish a new methodological school: the formal method in literary science. The seminar resembled a literary society without any formal order. In essence, it was a scientific discussion platform for the youth, which created the environment, the importance of which was mentioned above. Future formalists Yury Tynyanov (1894 – 1943) and Boris Eikhenbaum (1886 – 1959) took therefrom their idea of "the gay science" (which was the title of one of the central books of Friedrich Nietzsche). S.A. Vengerov was not only a prominent Russian literary scholar, but also a literary critic, publicist, and editor; he was among the first to implement accurate methods of analysis after collecting an extensive catalogue for his fundamental (but unfinished) "Critical Biographical Dictionary of Russian Writers and Scholars (from the foundation of Russian education to the present day)" (Vol. 1 – 6. SPb., 1889 - 1904) (Apokov, 2012).

The constructive changes of the early twentieth century also concerned the secondary school. The organization of school affairs in the early twentieth century shows that a simultaneous development of out-of-school education was required to immerse schoolchildren in the educational environment. Cultural and leisure activities that were popular in the early twentieth century included sports, excursions, clubs, and school press. This segment of press was, in modern terms, a hybrid or inverse medium, where science was combined with journalism, enlightenment, and esthetics. Knowledge in this context is learned immanently, based on teamwork, imitation, and games (Balashova, 2007).

However, probably the biggest result that enlightenment had on education was the fact that "by 1915, the country came close to achieving general education" (Collection of Documents, 2000).

When proceeding from enlightenment, which manifested itself through various social institutions, to a related subject – popularization of science, it is worth noting that its main channel was and still is the press, more precisely – popular-science magazines. Generally speaking, the magazine as a type of periodical first emerged in its scientific incarnation (first magazines that appeared in France and England were scientific ones).

In nineteenth-century Russia, popular-science works were published on a regular basis first in encyclopedic and then in the classical large-volume magazines. This trend persisted in the early twentieth century, despite the fact that large-volume magazines lost their leading positions. One of the best Russian pre-revolution magazines – Russkoye Bogatstvo (Russian Wealth) (1876 – 1918) – was a literary, scientific, and social magazine. At that, science was combined with criticism, for instance, in "Vesy" (The Balance) – a symbolist scientific-literary and critical monthly magazine edited by V.Ya. Bryusov or with journalism, for instance, in "Problems of Idealism" (M., 1902) and "Vekhi. Collection of Articles on the Russian Intelligentsia" (M., 1909) – the biggest social and philosophical digests of that time.

The prototypes of Russian popular-science magazines included British illustrated magazines. They influenced the popular-science press of Russia, since they were adapted by Russian illustrated weekly periodicals, considering the fashion for everything British that was prevalent at the turn of the nineteenth

and twentieth centuries and was described brilliantly by V. Nabokov in his autobiographical novel titled Other Shores. Novelties of foreign science and literature were brought to the notice of educated modern readers on a regular basis. A symptomatic fact was the emergence of the "Science and Civilization News" segment in the popular small-volume illustrated magazine titled Vsemirnaya Illyustratsiya (World Illustrated) (1869 – 1898), which in combination with its supplements had a significant influence on the further development of popular-science magazines. In the early twentieth century, newspapers started featuring the scientific society chronicler (reporter) position. Popular newspapers began using scientific agendas to form newsbreaks in terms of sensationalism (the circumstances, in which a whale was caught, etc.). Mass periodicals generally gravitate towards the popular-science element. For instance, "Sovershenno Sekretno" (Top-Secret), one of the first Russian tabloids that was launched during the Perestroika, still considers itself a popular-science newspaper. This is additional evidence of the latent interest of the Russian general audience in science, which should be explicated. This interest was mentioned by Pyotr Kapitsa. The Russian audience is traditionally interested in acquiring scientific knowledge, which gives ample opportunity for popularizing science, which is underutilized at present.

During the soviet revolutionary activity in Russia, the popularization of science was aimed at developing the class consciousness of the proletariat, developing its worldview and critical and active attitude towards reality. In addition, the state program that aimed to eliminate illiteracy was launched during the soviet period. According to this program, all people aged 8 to 50 were obliged to learn the basics of how to read and write (Bailes, 2015).

Discussion and Conclusion

Expert computer-assisted knowledge assessment systems, based on didactic tests and on various approaches to grades' assignment and aimed at providing high-quality education, are becoming increasingly popular.

In this regard, the tasks related to the criteria of assessing educational activity are some of the most challenging ones in modern pedagogics.

The analysis carried out as part of this study suggests that tests items requiring responses of the selected and selected-expandable type do not always provide an opportunity of evaluating students' knowledge objectively, especially in social sciences and the humanities. This situation has obvious negative consequences, for instance, a decrease in the stimulating effect of knowledge testing on the students' cognitive activity and the educational process in general. Of special relevance is the need of creating an expert knowledge assessment system which allows to reveal students' real level of knowledge in social sciences and the humanities, i.e. the subjects, where emphasis is placed on human knowledge and reflection.

The pace of addressing methodological problems and creating new knowledge assessment methods falls short of the opportunities of expert computer-based knowledge assessment systems. Didactics of the 21st century

strives for control and appraisal of the educational process at every stage, from the elaboration of aims and content to checking results. That is the reason for continuous intensive search of ways and means of improving knowledge assessment with a view to enhancing the quality of education (Elliot, Wilson & Boyle, 2014).

The results of this study can be used in general pedagogics as well as in theoretical and practical testology. The paper substantiates the need to take a new approach to responding to a test item, i.e. a freely constructed test item and test response, as well as the necessity for elaborating the criteria of analyzing such responses and for a research-based approach to their evaluation. The processing of the entire information contained in test responses is carried out with the help of algorithms of analyzing test responses and computer means of processing data. This offers an opportunity to get an all-round objective evaluation of knowledge. The test procedure is rigorously formal, but its result proceed from the responses given by the test-takers.

The practical significance of the research consists in the fact that we have set up an expert system of knowledge assessment, *IMKE*, which can be used for improving knowledge evaluation in social sciences and the humanities and enhance the quality of education in general. It provides for solving the scientific problem of objective and accurate knowledge assessment by means of an expert computer-based system of testing.

Many years of research by various authors suggest that a grade that represents the level of a group student's knowledge must be normally distributed. Therefore the most effective system of knowledge assessment is the one that does not overstate or skew the average grade in a group's responses. This implies that the hypothesis of the normal distribution of grades in the monitoring of the education process is the main working hypothesis (Van den Hurk et al., 2014).

Using this hypothesis in our work, we checked the veracity of the results of knowledge assessment by means of expert system of knowledge assessment *IMKE*.

The results obtained in the study do not address all the aspects of the problem of quality of knowledge obtained in the process of education. Further theoretical and practical elaboration of this subject requires solution of such problems as improving the integral method of assessment as regards an increase in the quantity of criteria of knowledge assessment, elaboration of criteria of assessing them, development of a knowledge base, involvement of various kinds of analyzers etc.

Implications and Recommendations

The analysis showed that the selected design of test questions and answers (questions that implied answers of selective and selective-constructed types) do not always provide objective assessment of the students' knowledge. This situation has obvious negative consequences: reduced stimulating effect of assessment on cognitive activity of students, as well as on the quality of the

entire training process. What seems especially important - the need to establish an expert system of knowledge assessment and control that would determine the actual level of student knowledge related to the social and humanitarian subjects. The expert system of knowledge assessment and control IMKE provided effective solution of these problems.

The originally developed expert system of knowledge assessment and control IMKE was put into the learning practice; this system can be recommended to improve knowledge assessment and control as regards social and humanitarian subjects with a view to improve the training quality. This enables using the research results to solve the scientific problem of objective and reliable knowledge assessment by using expert system of knowledge assessment and control.

The paper theoretically justified the need for a new approach to finding answers to the test question, allowing free - constructible form of test questions and answers, as well as the need to develop the result analysis criteria and the scientifically based approach to their assessment. Processing of full test result data is carried out through the developed algorithms for calculating the criteria for test result analysis, and software tools providing a comprehensive and objective assessment of knowledge. The pedagogical testing procedure is strictly formalized in this regard; however, the results become clear from the student responses.

The developed expert system of knowledge assessment and control IMKE, based on the integral method of knowledge assessment, provided the improved training quality through obtaining the objective information on the degree of knowledge assimilation by students. The interest and learning motivation of students were significantly increased

Disclosure statement

No potential conflict of interest was reported by the authors.

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