THE EMPIRICAL DATA COLLECTION AND PROCESSING AS A FACTOR OF RESEARCH ACTIVITY EFFECTIVENESS

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Abstract: A modern scientific development cannot be imagined without the use of a statistical methodology, which is based on the empirical research. So, it is necessary for social and economic development of the whole society. The level of young scientists' ability to conduct the empirical research can be considered as a quality factor of their future research activities.

The preliminary analysis of young Kazakh scientists' works showed very little applicability of systems and technology use for the processing of statistical data. The objective is to determine the main critical points in the empirical research that cause the most trouble in the applicability of the statistical research methods, systems and data processing technologies for the writing of Undergraduate level final qualifying works.

The analysis of existing empirical data processing technologies and their level of accessibility to university students was made in order to address this problem. The investigation was conducted among Undergraduate courses across 56 departments in different directions, the main reasons were identified and the analysis of possible ways to overcome the causes was made. An example of a particular case decision and simplification of the empirical data processing is also presented in the research findings.

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Introduction

Social and economic development of the modern world cannot be materialized without such processes as collection, processing, and analysis of empirical data. The vast majority of economic, market, or sociological research is based on statistical methodology. "Famous Deming considered statistical research methods to be the foundation of management methodology… professor of Ishikawa acquired world recognition thanks to progress in statistical research application" (Shuster, 2010). Social research involving a large number of responders becomes an important information source for a wide range of questions (Zanuttoa & Gelmanb, 2001). Thus, it is necessary to realize the importance of empirical calculations in every particular branch of scientific research.

In the modern world, competitiveness is one of the necessary conditions of activity support both at the individual level and at the State level. Innovative development as a competitiveness factor is today's reference point for many countries in the world. This direction is important not only in the sphere of production, business, economy, and management, but it is also very important in education. The educational task is to promote disclosure of talented youth potential by means of innovative technologies, as well as to involve talented youth in the creation of competitive national and world economy, and formation of ecologically safe activity by means of innovative development.

Background

Innovative development and innovative capacity of the country is a basic component of integration processes in the world community, pursuing support of a sustainable development and peaceful co-existence on the planet Earth.

In the last decade, close attention was paid to innovative processes by counteraction to world crises and search of stable forms of coexistence and creation of stable global economic system, without damaging the environment.

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Due to Global Innovation Index[3], analytical research is taken part not only by large private companies, e.g. Bloomberg L.P.[4,5], but also by major consulting firms, e.g. Boston Consulting Group, together with National Associations of Vendors, and Production Institutions[6]. In 2013, the 6th release of the Global Innovation Index 2013 [GII 2013] (Dutta, S. & Lanvin, 2013) was published with the integration of results received from such authoritative organizations as Cornell University, INSEAD, and the World Intellectual Property Organization (WIPO, a specialized agency of the United Nations). In cooperation with Knowledge Partners, Advisory Board, and Statistical audit by the Joint Research Centre of the European Commission, results of ranging innovative development from 142 countries in the world on the ten key indicative parameters were measured, generalized, and provided.

GII 2013 (Dutta, S. & Lanvin, 2013) recognizes the key role of innovation as a driver of economic growth and prosperity and acknowledges the need for a broad horizontal vision of innovation that is applicable to both developed and emerging economies, with the inclusion of indicators that go beyond the traditional measures of innovation (e.g. the level of research and development in a given country).

Kazakhstan, based on GII 2013, has weaknesses in the innovation efficiency ratio, which placed the country at number 84 in the 142-country ranking. Unfortunately, we have yet to occupy higher levels in these ratings on which we are purposefully oriented in the development of our country. Reforms in all management systems, accepted laws, normative legal acts, and programs are proof of the active movement contributing to achieving these goals. In Kazakhstan, special attention is paid to the educational system. In 1997, Kazakhstan ratified the Lisbon Convention aimed at developing a normative foundation of international cooperation in the sphere of Higher Education, and gradual entering of the national educational system onto the world stage (Pak, 2010). Recognizing efficiency and the significance of implementing basic principles of the Bologna Process in 2010 (Budapest-Vienna Declaration [B-VD], 2010), Kazakhstan became the 47th new fully participating country of the European Higher Education Area (B-VD, 2010), which predetermined a development vector in Higher Education and structural formation of research and development activities in Kazakhstan. The 3-stage system of training for specialists through Higher Education was initiated, with mandatory guiding of research and development operation (Resolution of the Government of the Republic of Kazakhstan No. 1080 [RGK-1080], 2012). The three stages comprising:

1. First stage—a Bachelor's Degree or the Higher Vocational Education:
   a) Bachelor's Degree with 4 years of training—at least 146 credits (including practice and at least 129 credits of theoretical training);
   b) Higher Vocational Education with 5 years of training—at least 178 credits (including practice and at least 161 credits of theoretical training).
2. Second stage—a magistracy:
   a) Magistracy profile with 1 or 1.5 years of training—at least 28 or 48 credits (including practice and at least 18 or 36 credits of theoretical training);
   b) Scientific and Pedagogical Magistracy with 2 years of training—at least 59 credits (including practice and at least 42 credits of theoretical training).
3. Third stage—Doctorate studies with 3 years of training—at least 75 credits (including practice and at least 36 credits of theoretical training).

[3] For more information please visit http://en.wikipedia.org/wiki/Global_Innovation_Index_%28INSEAD%29
[4] For more information please visit http://en.wikipedia.org/wiki/Bloomberg_L.P.
[5] For more information please visit http://en.wikipedia.org/wiki/Global_Innovation_Quotient
[6] For more information please visit http://en.wikipedia.org/wiki/Global_Innovation_Index_%28Boston_Consulting_Group%29

Dynamics of the educational system development is supported with systematic increase of the budgetary expenditures in development of research and related activities. According to the Decree of the President of the Republic of Kazakhstan No. 958 (2010), if expenditures on science in Kazakhstan contributed to only 0.2% of gross domestic product in 2009, then by 2015 it is planned to bring this index up to 1%, and 60 percent of these funds are planned to be allocated for research and development (Nazarbayev, 2011). Today in the Republic of Kazakhstan, the budget already scheduled for science and education in 2014 is about $3 billion (Law of the Republic of Kazakhstan, 2013).

Although the plan to raise the science expenditures up to 3% of the GDP is still insufficient, for Kazakhstan, it is a significant growth since the Republic has come to an understanding of the importance of these expenses and benefits in return. The dynamic growth of expenditures on science shall correspond to an increase in knowledge level. Growth level of expenditures shall be in harmony with the readiness level of young scientists to conduct research and development, and other developmental activities.

Special attention to research and development activities of students is an index of understanding the significance of the personnel potential development, which increases the capability to conduct critical analysis, research activities, and rational use of national resources.

Transition to the academic freedom of Higher Education Institutions shall lead to closer cooperation with production and labor markets, with opportunity provision within specialties of the Higher Education to develop independently different educational programs according to the National frame of qualifications, professional standards, and coordination with the Dublin descriptors and the European frame qualifications (RGK-1080, 2012).

At the same time, production growth stimulation in the knowledge-intensive leaves more and more notable deficit of qualified personnel. In order to address this problem, many grants were given in the past five years for training young generations of Kazakh in the field of technical, technological, and medical science[7]. Table 1 shows the number of awarded grants from 2011 to 2014.

Table 1: Number of grants given for training on an Undergraduate level in Kazakhstan, according to the directions of preparation in 2011-2014

Preparation direction (Undergraduate level)	2011-2012 academic year	2012-2013 academic year	2013-2014 academic year
Pedagogical specialties	8375	6664	6794
Technical and technological specialties	12227	12000	12497
Medicine and healthcare	5065	5000	4564
Agricultural and veterinary science	2560	2630	2650
Natural-science specialties	1350	1350	1450
Other specialties	6469	4396	7098

Source: Authors

However, there is a low demand of specialties in physical and mathematical, technical and technological direction in Higher Education Institutions that leads to a low competition in the selection process of Higher Education Institutions, resulting in a rather low level of knowledge of the Kazakhstani school graduates (except for leading Kazakhstani and foreign Higher Education Institutions, including partners in “Bolashak” system).

Attention to Higher Education quality must be deliberate, according to Douglas (2010), “it is probably not too much of an exaggeration to say that the both the social and economic future of nations and

[7] For more information please visit http://www.edu.gov.kz/ru/

regions will depend heavily on the educational attainment of their population, and, as a corollary, both the size and quality of their Higher Education institutions and systems. In post-modern economies, and increasingly in developing economies, there will be growing dependency on supported and expanding 'knowledge accumulation' that will be vital for greater national productivity and global competitiveness."

One of the main objectives of the modern Secondary Education in Kazakhstan is the training of specialists, possessing methodology and techniques of acquiring scientific knowledge, the modern information technologies, and capability to solve analytical, research and development problems. Undoubtedly, preparation for analytical, research, and development activities should have already begun in Secondary Education (Eichler, 2008; Gritsenko, Pigalitsyn, & Reyman, 2010; Bezrukova & Bezrukov, 2013).

Currently in the educational system of Kazakhstan, there is no accurate demarcation for the readiness level for this type of activity, even though the pupils are actively participating in research and development (elective) activities and creation of scientific projects in the school system. Thus, according to RGK-1080 (2012), the competency level of the general secondary education is noted by such skills as: a) ability to analyze, process, synthesize, and use scientific information; b) possession of methods for acquiring knowledge, design, research construction, and creative application; c) ability to work with the modern information communication technologies, devices, etc. The system of the higher education is encouraged integration of technological, analytical, research and development activities into the training stage at a Bachelor's Degree level by implementing the principle of indivisibility of teaching and research.

"Research work of students is a continuation and deepening of educational process and is organized on chairs, in laboratories, scientific, and design divisions of Higher Educational Institutions, in student's scientific and technical associations (design and other offices, centers, research institutes, etc.)" (RGK-1080, 2012). Though the common competency at this step of education is designated, there are no legibly expressed criteria for their level of readiness. Certainly, preparation in different specialties has its own features; nevertheless, in our opinion, the minimum literacy has to be dictated by the current state of science.

A lot of research is devoted to competency development in Higher Education Institutions in the spheres of "informational and communicative technologies" (Maleki, Majidi, Haddadian, Rezai, & Alipour, 2012; Sari & Mahmutoglu, 2013), "methodological literacy" (Ryndina & Kungurova 2013), "statistical literacy" (Nikiforidou, Lekkab, & Pange, 2010; Wade & Goodfellow, 2009), and work with larger data files, so-called "Big Data" (Sakoyan, 2013; Chernyak, 2013), all of which should be considered as the central theme in science.

The cross-analysis of curricula, programs, and educational standards in Kazakhstan in undergraduate specialties revealed an unclear position in the studied direction of the readiness level. Thus, the cross-analysis of available research of young Kazakhstani scientists indicated a small applicability of systems and technologies usage for statistical data processing. We asked a question on the preparation level of non-general theoretical knowledge base for conducting research (extremely important in our opinion), and concrete "instrumental applications and abilities." The task was set 1) to outline a circle of practical questions inquiring students in the final years of their Bachelor's Degree of the competency for conducting research activity, and 2) to find out the point of failure in empirical research, which causes the greatest difficulties in the applicability of mathematical-statistical research techniques, systems, and technologies of data processing—when writing their Undergraduate qualification works.

Method and Findings

To achieve the first objective of the research, an interview was conducted with the supervisors of graduate qualification projects. The interview was carried out at the university among teachers and professors holding scientific degrees. The interviewer did not mention the purpose of the questions. The research was aimed at exploring different regions of Kazakhstan, estimating different branches of science. Scientists to be interviewed were chosen independently of their age and gender. However, there was no special selection and opinions were asked mostly at random, if the interviewee displayed a positive reaction toward the questions being asked.

The respondents consisted of 32 people: 5 were Doctors of Sciences, 24 were candidates of sciences, and 3 had a Ph.D. The interview report includes a graded list of practical skills for any Undergraduate student to possess, in order to effectively write and defend a research qualification paper from any given list of topics. The list of practical skills and their response ranking are shown in Table 2.

Table 2: Response ranking according to the necessity choice

№ n\n	**List of necessary practical skills**	**Must have**
1	scientific information retrieval skills (including internet search)	**32**
2	working with the literature: quotations, annotation, note-taking and bibliography management	**32**
3	the research methods and ability to apply them correctly	**32**
4	constructing an educated report and preparing presentation	**32**
5	conducting surveys independently, as well as interviews and expert interviews	**31**
6	deriving a theme, distinguished purpose, and objectives of the study	**31**
7	organizing the observation	**29**
8	performing every stage of scientific research independently	**29**
9	formulating a hypothesis and creating a plan of research	**29**
10	analyzing the results using statistics and math, and being able to interpret results, including:	**29**
	- ranking, indexing, scaling	29
	- calculating arithmetic average	27
	- correlation analysis	15
	- analysis of the reliability of the results, analysis of variance	9
11	search systems usage and processing of statistical data	**23**
12	utilizing special software and processing large arrays of data (MS Excel, SPSS, SAS, Statistics, etc.)	**23**
13	using modern diagnostics equipment	**15**

Source: Authors

To achieve the second objective, we conducted a survey among Undergraduate students in their Junior and Senior year in Kazakhstan universities (both public and private). Undergraduate students of various specialties were chosen, but, primarily, three groups were interviewed: pedagogical, technical and technological, as well as agricultural, which has the highest priority in Kazakhstan. To verify and compare the results, the survey was conducted among the students in other fields, except for medical faculty, due to the differences in the requirements for the educational process in these specialties (duration and other criteria).

The total number of respondents was 567. The structure of the sample is shown in Table 3.

Table 3: Quantitative structure of respondents

№ n\n	Scientific direction of training	Number of specialties	Number of respondents
1	Education	18	208
2	Technical/technological	10	91
3	Agricultural	5	52
4	Economic	7	63
5	Social	4	28
6	Humanitarian	5	53
7	Law and security	7	72
	Total	**56**	**567**

Source: Authors

The questionnaire consisted of three blocks of questions, including 54 main and 23 supplementary questions, from which they were aimed to determine: 1) the knowledge level of the organizational stages of the research activities; 2) the problematic issues in the implementation of research stages; 3) difficulty in the process of working with empirical data. The questionnaire included both open- and close-ended questions. In analyzing the data using SPSS, a general analysis was made between groups. The most interesting results, in our opinion, are related to the matters dealt with in this article, where the comparative analysis was presented on specific issues between the directions of preparation. A general analysis was also conducted (in % of the samples) of all students' readiness level (Table 4).

Table 4: Comparative analysis of readiness for involvement in research and development activities of Undergraduate students in accordance with the directions of preparation (n = 567).

№ n\n	Scientific direction of training	Question 1* (%)	Question 2* (%)	Question 3* (%)	Question 4* (%)	Question 5* (%)	Question 6* (%)	Question 7* (%)	Question 8* (%)
1	**Education**	27.9	38.5	28.4	38.9	25.9	52.4	62.5	33.2
2	**Technical and technological**	31.9	20.9	23.1	33.0	32.9	40.7	41.7	27.5
3	**Agricultural**	51.9	55.8	51.9	53.9	46.1	84.6	59.6	26.9
4	**Economic**	19.1	15.9	11.1	12.7	20.6	52.4	53.9	46.03
5	**Social**	28.6	50.0	28.6	25.0	25.0	67.9	60.7	32.1
6	**Humanitarian**	9.4	18.9	13.2	28.3	28.3	26.4	58.5	13.2
7	**Law and Security**	45.8	55.6	59.7	51.4	52.8	72.2	56.9	23.6
In all fields of study		30.3	35.6	30.3	36.3	31.9	54.3	56.8	30.0

Source: Authors

Notes on the questions and the percentage of respondents they are related to:

- Question 1—Percentage of respondents for whom it does not cause difficulties to plan their research and formulate working hypotheses;
- Question 2—Percentage of respondents for whom a choice of the research techniques and data handling methods does not cause difficulties;
- Question 3—Percentage of respondents for whom data selection for carrying out empirical research does not cause difficulties;

- Question 4—Percentage of respondents for whom interpretation of data retrieved does not cause difficulties;
- Question 5—Percentage of respondents for whom the statement of the conclusions confirming or refuting hypotheses does not cause difficulties;
- Question 6—Percentage of respondents whose graduation paper completion implies empirical data processing;
- Question 7—Percentage of respondents who know something about computer programs for empirical data processing;
- Question 8—Percentage of respondents applying computer programs for data handling in their graduation papers.

It can also be noted that:

- 15.9% of the graduates are ignorant of empirical data processing;
- for 26.5%, interpretation of the results causes difficulty;
- for 33.2%, the greatest amount of time is taken by the collection and preparation of data for empirical treatment.

In the analysis of the results to the open-ended questions, the following general conclusions were made:

1) There is no deep understanding of the importance of this kind of activity for future professional work;
2) Existence of knowledge, but low abilities and lack of sufficient experience in many directions of conducting research work are noted;
3) The most popular applications used by students for processing empirical data are: Statistica, SPSS, and Stat (probably due to the lack of access to other software products);
4) Low access to these computer programs usage is noted (free of charge only for a demo version, expensive, or limited in capability);
5) Students are interested in the simple (available) tool of the results analysis;
6) The financial and temporary cost intensity on collecting and information processing is noted;
7) During the work with large volumes of selection, practically all manual data input into the computer increases probability of creating an error.

Conclusion

The conducted research indicates the need of closer attention to training Undergraduate students for the sphere of research activity, and also providing graduates not only with knowledge, but also with the competency and necessary research tools. It is necessary to strengthen this direction, first of all, by providing Higher Education system with the informational and technological software product equipped with methodical maintenance and prepared personnel structure. In particular, at Kostanay State Pedagogical Institute, research is conducted on simplification and cost reduction of the process of carrying out high-quality empirical data collection and its preparation for mathematical processing. Availability and the acquired competency have to increase interest and stimulate development of creative potential. For example, research is conducted in the direction of minimizing a mistake-making probability during the work with data (an exclusion of human factor influence on receiving objective results). Use of the software analog of the product ABBYY FlexiCapture, Cognitive Form, and also development of new forms and methods made available and affordable to students will enable quality improvement of the Undergraduate final writing works.

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