TEACHING AND LEARNING IN HIGHER EDUCATIONAL INSTITUTIONS BASED ON SCIENTIFIC APPROACH: SUCCESSFUL PRACTICES

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Abstract: This research aimed at studying the experience of using scientific approach techniques in teaching and learning in the world best universities. This goal was achieved through the secondary sociological statistical analysis of data, common and mathematical methods. It was found that the researcher skills developed during studentship allowed some graduates of the considered higher educational institutions (HEIs) to achieve significant personal success, as well as make their countries famous, promote their development by leading them, or establishing companies, making profits and creating jobs. The results of this study can be useful for teachers and researchers working on improving the efficiency of teaching and learning in HEIs.

Key words: university rating, curriculum, student research, teaching in HEI, scientific method

1 Introduction

In the era of rapid scientific and technological progress and the development of information technology, when the volume of information is growing rapidly while quickly losing its currentness, the education system faced the problem of finding new approaches to teaching and learning in higher educational institutions (HEIS). Simple memorization of long-known laws of nature is insufficient for the training of highly qualified competitive specialists, and the number of theories that have emerged over the past few decades do not provide such a possibility. In addition, in a few years they may become outdated. HEI teachers and scholars around the world are working to solve this problem. In addition, the economies of countries are mainly developing not because of the subsoil they use, but innovations created by scholars of these countries. Therefore, the scholar's role has recently increased significantly, which emphasizes the urgency of preparing the younger generation of scholars.

It is important today to find such approaches to teaching and learning that optimize the educational process in HEIs, and will be able to give students the necessary knowledge, skills and abilities to fulfil themselves in life. There are many works in the scientific literature, which consider different ways to improve the quality of higher education. But there is a need to generalize the existing approaches to teaching and learning in HEIs, and to study successful practices, in particular, the scientific approach.

(Yermachenko & Derykhovska, 2017) have already studied the problems and outlined the opportunities for higher education systems in different countries. (Sheikh, 2017) studied the challenges and opportunities of higher education in India. (Pinheiro et al., 2019) dealt with the features of higher education in Europe, in the United States — (Salvioni et al., 2017), Saudi Arabia — (Aldiab et al., 2019), Malaysia —(Meylinda et al., 2018), Indonesia — (Siayah & Setiawan, 2020; Bublyk et al., 2019), as well as (Yermachenko & Derykhovska, 2017) and (Sahaydak et al., 2020) studied the situation in Ukraine.

(Pinheiro et al., 2019) described the model of a European university on the example of the universities of Denmark, Sweden, Finland and Norway. They view universities as a sector of the economy and try to determine roles for university administration, faculty and academics in order to increase the productivity of their joint work.

(Salvioni et al., 2017) studied the American model of higher education and analysed the content and methods of teaching. (Drummond & Fischhoff, 2017) proved that the level of education influences a person's worldview and his/her attitude to global, for example, political or religious issues.

Among the proposed methods that should help raise the effectiveness of education, (Aldiab et al., 2019) propose, for example, to use learning management systems (LMS) in addition to the traditional classes in HEIs, which provide access to lectures at any time, a convenient, objective way of taking exams, receiving feedback, receiving assignments and discussing problems during video conferencing.

(Yermachenko & Derykhovska, 2017) argue that the focus of universities on research is the current global trend in higher education. Students are involved in research while studying at the university, thus acquiring the ability to carry out scientific research, design, model, engage in inventive activities.

(Sahaydak et al., 2020) studied the influence of scientific approach on building students' worldview in general, and the system of values, erudition, safety culture and environmental awareness in particular.

(Lozano et al., 2019) and (Salvioni et al., 2017) deal with the application of the scientific approach to building basic principles of sustainable development. (Sahaydak et al., 2020) considered the forms of student activity that help in the implementation of a scientific approach to learning.

(Harlin, 2018) showed the benefits of using scientific methods in teaching and learning. (Drummond & Fischhoff, 2017) pointed out the shortcomings cause by excessive enthusiasm for the scientific method in teaching. (Stella, 2020) investigated the attitude of students to the use of a scientific approach in learning. (Balzyn & Ergyn, 2018) found that students mostly abandoned the stereotype "every scholar is a bit crazy". Now, the teacher is perceived as a leader in science, a mentor. (Stella, 2020) also emphasizes that the scientific approach has shifted students' attention from the teacher's personality to the object of study, and made them change the attitude to learning and to the educational institution to a more positive one.

There are different interpretations of the scientific approach. Oxford University researchers (Cullinane et al., 2019) argue that there can be no single interpretation of the "scientific method" as a hypothesis test by experimental means. It should be considered more broadly. It should include offering a hypothesis, planning and conducting a study, analysing the data obtained, making explanations and drawing conclusions.

(Bublyk et al., 2019) conducted a detailed analysis of the scientific component of higher education systems in different countries and in Ukraine. However, there are still limitations in the use of the scientific approach in teaching and learning in HEIs. The scientific method is widely used in students' term papers, dissertations, but little is used directly in the acquisition of new knowledge, for example, during lectures, seminars, and even during laboratory or practical work. This research aimed at

studying the successful experience of applying scientific approach in teaching and learning in the world best universities, which will allow its widespread introduction into the educational process of all HEIs.

To achieve this goal, we set the following objectives:

1. Show how the application of the scientific approach in teaching and learning in HEIs impacts the professional fulfilment of their graduates.
2. Determine the impact of the level of quality of higher education on such indicators of development of society and the country as a whole as the Global Innovation Index, the Human Development Index, the number of patent applications and GDP per capita (Global innovation index, 2019; Human development index, 2019; World Intellectual Property Organization. *Statistical country profiles*, 2019; International Monetary Fund. *World Economic Outlook Database*, 2020).

2 Methods

The successful practices of applying the scientific approach to teaching and learning in HEIs were studied in the following stages: 1) the world best universities were selected for research; 2) we studied their structure, as well as areas of training of students and areas of research; 3) we examined the approaches to teaching at selected universities, curricula and course programs taught to students, as well as the requirements for knowledge, skills, abilities that they must acquire; 4) we analysed in which areas university graduates have succeeded and what achievements they have; 5) we assessed how the level of quality of higher education in the country affects the Global Innovation Index, the Human Development Index, the number of patent applications and GDP per capita (Global innovation index, 2019; Human development index, 2019; World Intellectual Property Organization. *Statistical country profiles*, 2019; International Monetary Fund. *World Economic Outlook Database*, 2020).

The World University Rankings 2021 (The world university rankings, 2021) were used for sampling and implementing the first stage of the study, which summarizes information obtained from 1,500 science-intensive HEIs of the world. This ranking of universities is based on 13 performance indicators divided into the following five groups: education, research, citations, international relations, income in the industry. The subjects selected were top ten 10 universities in this ranking.
The fourth stage of the study was implemented with the sample consisted of well-known graduates of two universities in the top ten as (The world university rankings, 2021) states.

The sampling procedure of the fifth stage was as follows: we randomly selected countries included in (21), which was made by comparing national performance in four areas: the strength of the higher education system (evaluates the place of the country's universities in the overall ranking of universities), accessibility (the ratio of the number of places in the country's universities to the country's population), the results of the main components of the system (results of the country's leading institution in the world ranking), and economic factor (the impact of state investment in the higher education system).

The second and third stages of the study involved common methods, in particular, the review of the scientific literature on the application of the scientific approach in teaching and learning in HEIs studied in this paper.

At the fourth stage of the research, we used statistical analysis of available data on graduates of HEIs in order to identify the impact of scientific approaches used in teaching and learning in HEIs, their professionalism, as well as social, economic life and science development in the country.

Mathematical methods were used at the fifth stage of the study, in particular methods to determine functional dependencies, in order to assess how the level of higher education in the studied countries affects such parameters as the Global Innovation Index, the Human Development Index, number of patent applications and GDP per capita (Global innovation index, 2019; Human development index, 2019; World Intellectual Property Organization. *Statistical country profiles*, 2019; International Monetary Fund. *World Economic Outlook Database*, 2020).

3 Results

In order to study the experience of teaching and learning in the top ten HEIs in the world according to (The world university rankings, 2021), we analysed the content of curricula and programs, as well as the research and methodological framework they have. The results of the analysis are presented separately for each university.

1) Oxford University (Oxford University Official Website, 2021) The review of curricula and plans showed that the main role in managing the process of implementing the scientific approach in teaching rests with the teacher. It is he/she who should lead the student to a research problem and evoke the desire to solve it. In this case, the student should use various methods of scientific research, analysing changes over time, grouping and classifying certain objects of research, noting patterns. Besides, experiments should be conducted where one can influence the change in parameters and where one can only observe their change and measure it. The students should explain the results using various sources of information, as well as their own knowledge and understanding of the studied processes (Cullinane et al., 2019). The scientific approach excludes the possibility of the teacher presenting a ready-made algorithm for solving the scientific problem facing the student, which makes students think that science is too simple and never unsuccessful.

It should be emphasized that the scientific method does not always have a strictly defined structure. The history of great discoveries knows many cases when scientists simply observed the phenomenon without formulating a hypothesis before observation, and made conclusions about the patterns based on the results of observations.

There are several styles of teaching at Oxford University: the teacher explains what the student does not understand; the teacher shows his/her vision of the subject to the student; the teacher shows the relationship between certain objects, encouraging the student to develop a new perspective in the broader context of the subject being studied; the teacher and the student exchange points of view and interpret the problem being studied in a new way.

According to a survey of 2,330 students at Oxford University (Trigwell & Ashwin, 2003), there are several approaches to teaching and the educational process in general. In particular, a deep approach, which is to encourage students to find the meaning of what is being studied and understand the basic ideas. This approach awakens students' interest in research and an anticipation of satisfaction in obtaining results. On the way to achieve results, students can satisfy their curiosity, apply their experience, compare and differentiate arguments, find patterns, identify basic principles, combine knowledge with existing ones, considering them part of the whole knowledge, theorize and summarize the results and make certain conclusions. This approach leads to better learning by students and higher scores.

But along with a deep approach, superficial one is also used in learning. In this approach, students' assignments are perceived as an external imposition, which they must solve with minimal effort. Most often, students resort ot maximum memorization without a deep understanding of the components and their relationships, and subsequent reproduction as accurately as possible, in order to obtain a higher score, rather than to understand the material. However, learning outcomes with this approach are not always rated high.

Research (Trigwell & Ashwin, 2003) has shown that 68% of Oxford University students believe that their professors adhere

to a deep approach to teaching. However, a quarter of students believe that learning is reduced to memorizing ready-made opinions and facts presented by teachers, which does not contribute to the development of interest in the material and its deep understanding.

Most of the students surveyed support the use of such an approach in teaching and learning, when the teacher makes students think, and then give arguments to defend their opinion. However, in order to be able to defend one's opinion, one must already have some knowledge, which can then be referred to.

According to students, most professors at Oxford University try to involve them in the process of learning.

In addition to introducing a scientific approach to the study of various subjects, Oxford University is creating special programs for the development and training of researchers. They include a variety of activities and resources, like workshops to support graduate students and doctoral students. Their purpose is to support young scientists in their research and personal development. These include: online courses in statistics, the program for the development of presentation skills, online courses for writing a thesis and report. There is also advanced training for teachers, in particular, Progressive Program of Teaching and Learning.

This approach helps Oxford University students do a lot of research during their studies that has an impact on culture, business, politics, the environment and the health care system. Even more scientific discoveries have been made by graduates and staff of the university. Of course, the University's research base occupies not the last place in research activities.

2) Stanford University (Stanford University Official Website, 2021)
Teaching at Stanford University involves the development of students' skills in careful reading and interpretation of scientific texts. The teacher must be able to guide students in reading comprehension. The teacher must teach students to critically evaluate arguments and evidence.

During classes, the teacher should involve students in debates and help them identify and apply ideas of classical theories to contemporary issues.

Curricula are designed so that they can provide students with all the knowledge necessary for research activities. For example, quantitative skills (such as statistical and computational) as well as knowledge of programming languages and the necessary information environments are important for the development of science.

When teaching students, teachers should guide them through such important aspects of scientific methods as creating experimental projects, performing data analysis, and explaining the difference between correlation and causation.
The scientific approach in teaching and learning in the University also involves students writing scientific papers that should demonstrate a high degree of clarity in argumentation, the development of criticism, argumentation and response to this criticism.

In teaching and learning using scientific approach techniques, interactive lectures and scientific discussions can be used to teach students argumentation. The scientific method should include the formulation of scientific problems and offering hypotheses, as well as the development of new or a choice of existing tools and methods for testing them.

The material that teachers provide to students for study should be current, so that the importance of a scientific approach can be demonstrated on the example of solving the problems of the 21st century.

The solution of scientific problems, which requires knowledge of several subjects also contributes to the development of abilities that future scientists need.

Stanford faculty provide an opportunity for their students to better understand the application of the scientific method in solving a wide range of real problems and in the practical acquisition of knowledge based on facts that require the attention of science. In the process of solving such scientific problems, students must learn to design an experiment under the teacher's guidance, which in turn should develop the observation and measurement skills, teach quantitative analysis and modelling. At the same time, students should not neglect statistics when drawing conclusions of their research.

Teachers should teach students to understand the place of their own research in global science, show the power of scientific knowledge and teach students to communicate this knowledge to others, present it correctly, distinguish false knowledge from true, learn to navigate key concepts.

The organizational skills of a scientist are also important in research, because he/she must both self-organize to solve a scientific problem and be able to organize others for the same purpose. Stanford University faculty pay considerable attention to developing leadership skills in students when working on projects and participating in interactive sessions. Students must learn to negotiate and be able to manage complex conversations, as well as show the importance of the ability to express their opinion in science.

Teachers have a task to teach students to solve large, complex problems analytically, while abstracting from secondary issues.

3) Harvard University (Harvard University Official Website, 2021)
Harvard University students have the opportunity to engage in the study of applied, social sciences, the humanities and technical sciences. At the same time, teachers focus students' attention on current issues and scientific issues that need to be addressed. They provide the necessary knowledge and skills for this purpose. For example, they deliver quantitative data substantiation courses for the correct processing of data, where students learn to operate with computational, mathematical and statistical techniques. They are explained where these methods can be applied in the real world of modern data.

Considerable attention in teaching and learning at Harvard University is paid to developing scientific speech in students. Seminars and meetings are created between students and teachers for this purpose. Writing a term paper or dissertation is an integral part of a scientific approach to teaching and learning. Harvard University is no exception.

4) California Institute of Technology (Caltech Official Website, 2021)
The core curriculum of the California Institute of Technology provides students with the development of collaboration and communication skills needed to take on academic challenges. This gives them confidence and develops resilience. A necessary condition for teaching and learning at the University of California is the challenge of intellectual interest in the formulated scientific problems, as well as its satisfaction. Teaching and learning is based on the need for effective cooperation between teachers and students, built on the laws of ethics, using different models of interaction and different means.

Graduates of the California Institute of Technology must have an understanding of basic science concepts. They must be able to use disciplinary thinking, analytical skills and various scientific methods in solving research problems and problems in various subjects.

The knowledge and skills acquired while studying at the University allow graduates to be able to conduct research and expand knowledge in areas beyond their specialization. The

graduates can soundly analyse cultural, political and economic events.

5) Massachusetts Institute of Technology (Massachusetts Institute of Technology (MIT) Official Website, 2021)
Massachusetts Institute of Technology builds its teaching practice on the principle that before formulating scientific problems students must first acquire the necessary knowledge to find solutions to these scientific problems. This is done both theoretically and in practice. And when students have some educational experience, they can perform more complex tasks.

Massachusetts Institute of Technology, on the way to training new researchers, considers its key tasks not only to provide students with scientific knowledge, develop technical literacy, but also to teach to distinguish between problems that require scientific solutions, and to search for these solutions.

According to the curriculum, students must prepare diplomas. Special seminars on writing diploma projects are provided to acquaint students with the peculiarities of research. The purpose of the diploma is to deepen the student's knowledge in a specific field that corresponds to the topic of the work.

Student work in laboratories, discussions at seminars, group projects, independent research teach students to use the principles and methods of analysis, design and experimentation, which is the basis of the scientific method. In addition, students have the opportunity to gain practical experience working on industrial projects of the university or projects of partner companies.

6) Cambridge University (Cambridge University Official Website, 2021)
The approach used by the University of Cambridge in teaching and learning helps students to develop a creative approach to solving scientific problems. To do this, the university provides the necessary knowledge, develops a deep understanding of the basics of problems and develops the necessary skills to solve them. Teachers teach students to analyse the content of the task, to apply knowledge not only to already known problems, but also to new ones. They provide the necessary knowledge and skills for students to conduct independent intellectual research. They teach students to feel the changes and show flexibility towards them, to influence the results, as well as to be well informed.

7) University of California, Berkeley (University of California, Berkeley, Official Website, 2021)
The main purpose of applying scientific technology in the learning process at the University of California is to help students become leaders who are able to turn innovation into impact. Learning should help students to move from what they have to what he may have. Thus, students' knowledge accumulates thanks to learning through own experience of the resolution of the set issues.

At the University of California, students have the opportunity to conduct research on a topic of interest to the student. The research is carried out under the teacher's guidance. In addition, students at the University are taught subjects that help implement scientific methods. In particular, subjects are related to information and its processing. They make students able to plan research, obtain information from data sets, using analytical methods, visualize data, perform statistical analysis. They learn to interpret the findings of their research so that they can change their minds. The courses offered to students teach them to independently formulate current scientific problems, use various data and methods to solve them, as well as to formulate the correct conclusions that will complement the existing knowledge.

8) Yale University (Yale University Official Website, 2021)
Yale University curricula are designed to show respect for student initiative, to build on student maturity. Studying at Yale University involves teacher mentoring. The university has created a favourable learning environment for students to do compulsory research.

9) Princeton University (Princeton University Official Website, 2021)
Curricula are designed so that the knowledge that students gain in one subject is then used in the study of the next. In the process of learning, students analyse a number of complex issues in various academic subjects, thus acquiring skills in the use of quantitative and qualitative methods.

10) University of Chicago (University of Chicago Official Website, 2021)
University of Chicago provides students with the necessary knowledge of the basic sciences to prepare them for the development of new knowledge. At the same time, the University created a controlling, supporting and evaluating learning environment.

Besides, the University provides an opportunity to develop skills in doing research, which is to help partner organizations solve real problems. There is also a compulsory research that students must complete before graduating from the HEI, it is carried out under the teacher's guidance. The student chooses the topic.

The main approach to teaching and learning is continuous learning through research, refutation or confirmation of assumptions, intellectual debates. Scientific problems must be approached from the perspective of different subjects. Students are involved in considering a variety of views, academic experiences, minds, habits to enrich their knowledge and engage in activities.

Thus, 10 considered HEIs use scientific approach techniques in teaching and learning. Moreover, they do so at all stages: when teaching new material in lectures, when discussing current scientific problems in seminars, when performing laboratory research, when working on term papers or diplomas, when performing research commissioned by a partner organization of an educational institution.

This paper also investigated whether it is worth to use a scientific approach to teaching and learning in HEIs, because not all graduates become scientists. For this purpose, we considered how the approach to learning and teaching in the above HEIs affected the lives of their graduates on the example of famous graduates of Oxford and Harvard University. Famous Oxford University graduates include 58 international leaders, 120 Olympic medal winners, and 55 Nobel Prize winners. That is, a quarter of the famous graduates of Oxford University became scientists, and 75% of them fulfilled themselves in other fields.

It is clear that the education received at the university, where they often use scientific approach techniques in teaching and learning, did not prevent, for example, Clement Attlee, Tony Blair, David Cameron, Sir Edward Heath, Boris Johnson, Harold Macmillan, Theresa May, Margaret Thatcher and 20 other Oxford graduates became prime ministers of the United Kingdom. This did not also prevent Tony Abbott from becoming the Prime Minister of Australia, Grantley Adams — the Prime Minister of Barbados and the West Indies, Solomon Bandaranaike — the Prime Minister of Sri Lanka, Reese Ahmed — the actor, Tariq Ali — the writer, W.H. Auden — a poet. Scientific approach to studying at Oxford Baruch helped S. Bloomberg, John Eccles, Lord Florey, and 52 other graduates to become world-renowned scientists, inventors, and Nobel Prize winners.

The famous graduates of Harvard University include 45 Nobel laureates, more than 30 heads of state. The study showed that among 1,380 renowned graduates, the ratio of scientists to representatives of other professions is 2 to 3.

We also found out how the approach to teaching and learning in universities affects the population of the countries in which they are located, and the development of these countries.

According to (QS Higher education system strength rankings (HESS), 2018), which distributes countries according to the strongest higher education systems (using such criteria for evaluating higher education systems as system strength, affordability, performance and economic component), the top ten countries include: USA, UK, Australia, Germany, Canada, France, the Netherlands, China, South Korea and Japan. Ukraine took 44th place in this ranking.

If we analyse this ranking by universities, the top seven are: Massachusetts Institute of Technology, Stanford University, Harvard University, California Institute of Technology, Cambridge University, Oxford University, UCL.

To show the impact of education received with teaching methods offered by the universities described above, we analyse its impact on the lives of graduates by the following parameters: Global Innovation Index, Human Development Index, the number of patent applications per capita and GDP per capita (Global innovation index, 2019; Human development index, 2019; World Intellectual Property Organization. *Statistical country profiles*, 2019; International Monetary Fund. *World Economic Outlook Database*, 2020).

Let us expand the scope of the study and not be limited to only two countries with the 10 world best universities, but let us consider 18 countries randomly selected from 50 countries. (QS Higher education system strength rankings (HESS), 2018) Table 1 contains the data required for the study.

Table 1. Characteristics of countries according to 5 world rankings

Place in QS HIGHER EDUCATION SYSTEM STRENGTH RANKINGS [23]	Country	Total score in the QS HIGHER EDUCATION SYSTEM STRENGTH RANKINGS (21)	Population of the country (as of 2019), million. (18)	Human Development Index (2019) (17)	The Global Innovation Index (2019) on a 100-point scale (16)	GDP per capita (2019), international dollars (19)	The number of patent applications filed (18)
1.	USA	100	328.24	0.926	61.73	65,254	521,145
2.	United Kingdom	98.6	66.83	0.932	61.30	48,727	54,762
3.	Australia	93.8	25.38	0.944	50.34	52,726	12,568
4.	Germany	93.4	83.13	0.974	58.19	56,226	178,184
5.	Canada	90.4	37.59	0.929	53.88	51,190	24,469
6.	France	86.8	67.09	0.901	54.25	49,799	67,294
7.	Netherlands	84.9	17.33	0.944	61.44	59,693	35,359
8.	China	84.5	1,397.72	0.761	54.82	16,709	1,327,847
9.	South Korea	83.5	51.71	0.916	56.55	44,573	248,427
10.	Japan	82.1	126.26	0.919	54.68	43,194	452,130
14.	Sweden	74.8	10.29	0.945	63.65	55,265	27,721
20.	Finland	66.6	5.52	0.938	59.83	50,748	11,470
25.	Malaysia	58.6	31.95	0.810	42.68	28,991	2,122
30.	Norway	51.4	5.35	0.957	51.87	66,214	6,225
35.	Portugal	46.3	10.27	0.864	44.65	36,246	2,148
40.	Lebanon	31	6.86	0.744	28.54	15,134	0
44.	Ukraine	23.7	44.39	0.779	37.40	13,442	2,467
50.	Pakistan	14.7	216.57	0.557	25.36	5,204	411

Figure 1 demonstrates the dependences of the Human Development Index on the level of higher education in such countries as the USA, Great Britain, Australia, Germany, Canada, France, the Netherlands, China, North Korea, Japan, Sweden, Finland, Malaysia, Norway, Portugal, Lebanon, Ukraine and Pakistan.

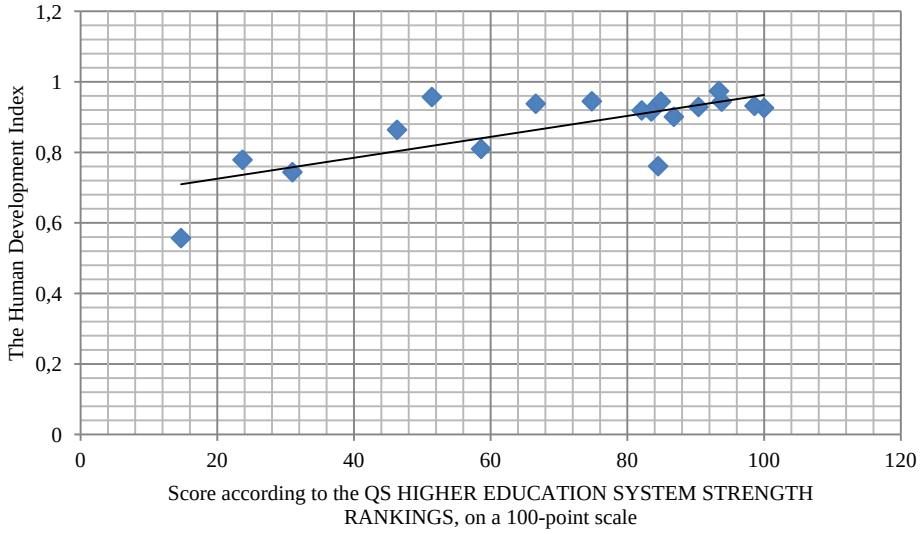

Figure 1. Dependences of the Human Development Index on the level of higher education according to the QS higher education system strength rankings (Human development index, 2019; QS Higher education system strength rankings (HESS), 2018)

Using the method of linear approximation, we obtained a function that describes the dependence of the Human Development Index on the level of quality of higher education in the country. It is y=0.003 x + 0.66. Figure 1 and the obtained function demonstrate that the higher the level of education in the country, the higher the Human Development Index.

We similarly obtained the dependence between the Global Innovation Index and the level of quality of higher education on the example of the studied 18 countries (Figure 2). The obtained dependence is: y = 0.36 x + 26.

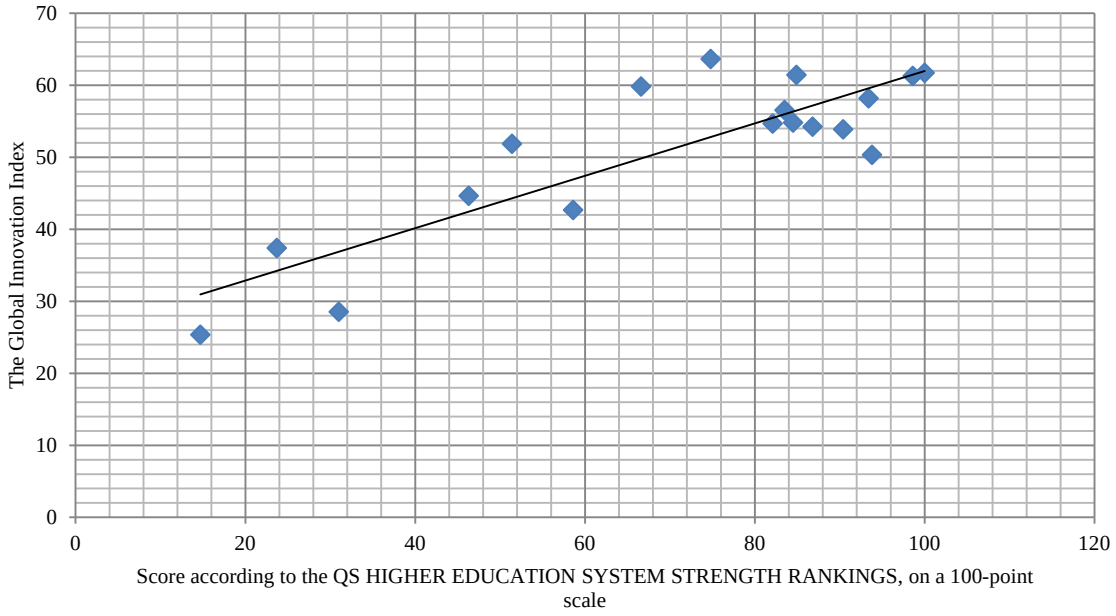

Figure 2. Dependence of the Global Innovation Index on the country's place in the QS higher education system strength rankings (Global innovation index, 2019; QS Higher education system strength rankings (HESS), 2018)

The level of higher education also affects the number of patent applications (Figure 3). This dependence can be described by the following mathematical function: y = 0.003 x - 0.036.

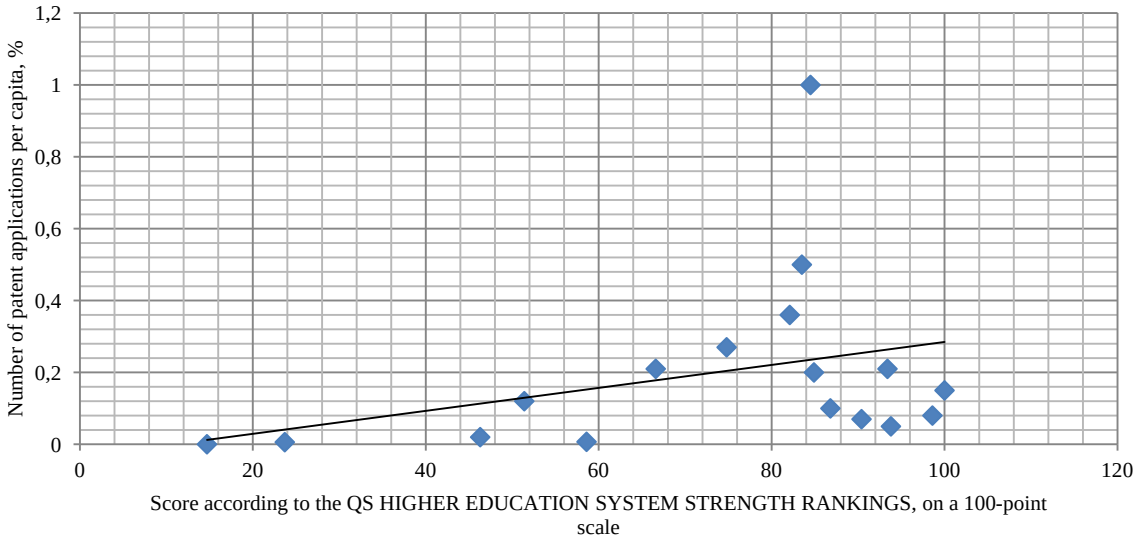

Figure 3. Dependence of the number of patent applications on the country's place in the QS higher education system strength rankings (World Intellectual Property Organization, 2019; QS Higher education system strength rankings (HESS), 2018)

However, the level of education has the greatest impact (among the studied parameters) on GDP (Figure 4). It is described by the following functional dependence: y = 500 x + 7000, where the angle factor is 500, being the largest of the considered ones (0.003 and 0.36).

Thus, the level of education has a positive impact on such characteristics of the population as the Human Development Index, the Global Innovation Index, the number of patent applications. However, the level of quality of higher education has the greatest impact on the country's economy, in particular on GDP per capita.

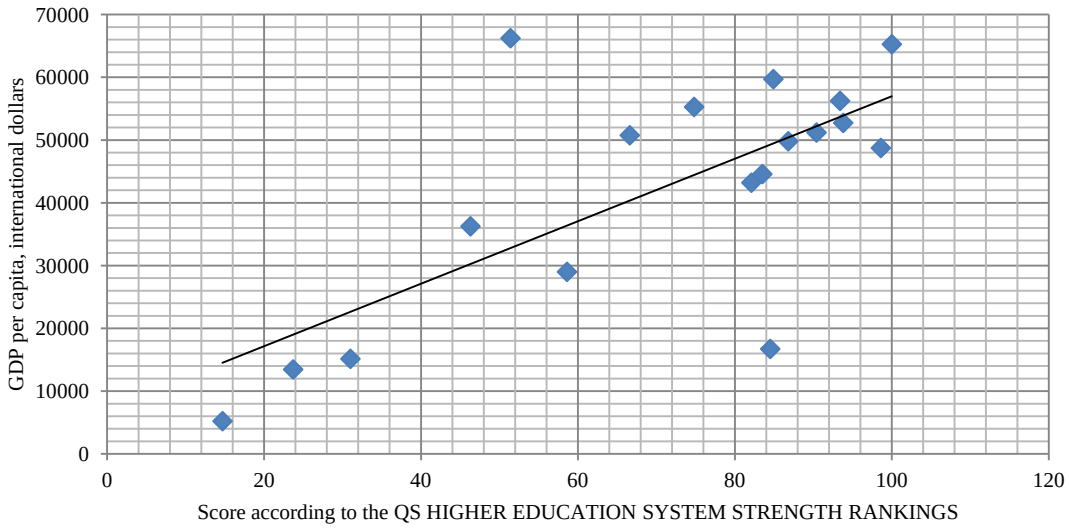

Figure 4. Dependence of the GDP per capita on the country's place in the QS higher education system strength rankings (19, 21)

4 Discussion

The scientific method appeared in education when schools began to study the results of scientific research. The scientific method was later replaced by laboratory one, that is science moved to the laboratory. But over time, the scientific method has become so popular that it has been used in everyday life. The problem that arose could be solved by a simple algorithm: gathering evidence and drawing conclusions. This in turn has led to the misconception that anyone can do science without the need to be a scientist. That forced teachers, most of whom were not scientists, to teach students how to do science.

So, what is the subject of study in educational institutions — science itself or the process of science — is an issue that has arisen before pedagogy in recent times. After all, only a small number of students, will connect their lives with science and become scientists after graduation. Will it not be a waste of time for other graduates to use scientific approaches in their studies.

(Susantini et al., 2018) believe that learning has a high degree of effectiveness when students learn new information using their own experience. Therefore, the teacher's task is to create a learning environment that would contribute to the student's need for research, and provide all the conditions for its successful independent realization. This will allow students to gain new knowledge on the basis of existing ones, and will allow applying new ideas to new situations. This is the scientific approach to teaching and learning — to learn science from the practice of scientific research: find the answer to the question posed to the student in the following stages: collect and analyse the necessary data, and formulate answers to questions based on data analysis.

(8) also emphasize the need for scientific education in HEIs and the importance of using a scientific approach that will enhance the scientific and cognitive activities of students, thereby cultivating demands on themselves in achieving results, and the need for constant updating of knowledge and skills.
But there are some opposing views (Pinheiro et al., 2019, Drummond & Fischhoff, 2017). In particular, there is a harm revealed from such an approach in the field of engineering, as engineers have turned into scientists from practitioners. Now, the level of qualification of an engineer depends on who was his teacher at the university — a research professor or practitioner (Klassen, 2018).

In addition, the scientific approach to teaching and learning in HEIs is often covered in the scientific literature only as one that can be implemented in additional classes, electives, clubs, conferences, competitions (Sahaydak et al., 2020) or when preparing term papers or diploma research. (Zaim, 2017) believes that the scope of the scientific approach in teaching in HEIs can be expanded. The scientific approach, which originates from the development of science, can also be used in regular classes in HEIs. In order for students to acquire new knowledge and integrate it with previous knowledge, it is necessary to apply scientific methods of studying the phenomena, that is to turn the educational process into "doing science".

The analysis of the curricula of the world best HEIs showed the possibility of using the scientific approach techniques in teaching compulsory subjects. The teacher should build the educational process to encourage students to formulate a scientific problem and find its solution, under teacher's guidance, while refraining from imposing his/her own thoughts on the student. According to (Schmaltz et al., 2017), the student must develop scientific thinking as a result of the scientific approach, that is the ability to generate, verify and evaluate statements, data and theories.

6 Conclusions

The research conducted in this paper showed the need to optimize higher education and find new more effective approaches to teaching and learning in HEIs. Through the analysis of educational processes in the ten world best universities located in the United States and the United Kingdom, we found that they use scientific approach techniques in teaching and learning.

The study of information about outstanding university graduates with a high level of scientific approach to teaching and learning showed that not all outstanding graduates have become famous scientists, there are also representatives of other professions, including politicians, artists, writers, poets, actors, Olympic medal winners. This indicates a positive impact of a scientific approach to teaching and learning on the future of graduates of HEIs, regardless of their future field of expertise.

A comparison of world rankings of countries in terms of the level of higher education, Innovation Index, Human Development Index, GDP per capita, and the number of patent applications showed a positive impact of the quality of higher education on the development of the country as a whole and the population in particular (Global innovation index, 2019; Human development index, 2019; World Intellectual Property Organization. *Statistical country profiles*, 2019; International Monetary Fund. *World Economic Outlook Database*, 2020).

Thus, the results of this study emphasize the importance of using scientific approach in teaching and learning in HEIs, and the need to expand its scope. After all, the scientific approach can be used not only in the preparation of term papers or participating in clubs and scientific conferences, but also when teaching new material during lectures, discussing scientific problems during seminars, solving scientific problems during laboratory work following the instructions and algorithms not prepared by the teacher but and as an own properly planned scientific experiment.

The study poses new challenges for teachers and researchers in the field of higher education, which is to adapt the international experience of using the scientific approach to teaching and learning in HEIs to domestic higher education systems, in view of the available opportunities for its implementation.

Literature:

1. Aldiab, A., Chowdhury, H., Kootsookos, A., Alam, F., Allhibi, H. (2019). Utilization of Learning Management Systems (LMSs) in higher education system: A case review for Saudi Arabia. *Energy Procedia, 160,* 731-737.
2. Balzyn, M.D., & Ergyn, A. (2018). Secondary school students' perceptions and attitudes about scientists. *European Journal of Education Studies, 4*(4), 66 – 93.
3. Bublyk, S.G., Velenteichyk, T.M., Goncharova, T.V. (2019). World trends in the development of higher education and the place of the research process in it. *Science and Education, 1,* 46-67
4. Caltech Official Website. (2021). Available from: https://www.caltech.edu/
5. Cambridge University Official Website. 2021; Available from: https://www.cam.ac.uk/
6. Cullinane, A., Erduran, S., Wooding, S.J. (2019). Investigating the diversity of scientific methods in high -stakes chemistry examinations in England. *International Journal of Science Education, 41*(16), 2201–2217.
7. Drummond, C., & Fischhoff, B. (2017). Individuals with greater science literacy and education have more polarized beliefs on controversial science topics. *PNAS, 114*(36), 9587–9592.
8. Global innovation index. (2019). Available from https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2019.pdf
9. Harlin, J. (2018). Turning students into citizen scientists. In J Harlin, L Kloetzer, D Patton, C Leonhard, Citizen science: innovation in open science, society and policy (pp. 410 – 428). London: UCL Press.
10. Harvard University Official Website. (2021). Available from https://www.harvard.edu/
11. Human development index. (2019). Available from: http://hdr.undp.org/en/content/latest-human-development-index-ranking
12. International Monetary Fund. *World Economic Outlook Database.* (2020). Available from: https://www.imf.org/en/Publications/WEO/weo-database/2020/October
13. Klassen, M. (2018). The academization of engineering education in the United States and the UK. A neoinstitutional perspective. Paper presented at the Higher Education Annual Conference at Newport, Wales, UK.
14. Lozano, R., Barreiro-Gen, M., Lozano, F.J., Sammalisto, K. (2019). Teaching sustainability in European higher education institutions: assessing the connections between competences and pedagogical approaches. *Sustainability, 11*(6),1602-1 – 1602-17.
15. Massachusetts Institute of Technology (MIT) Official Website. (2021). Available from: https://www.mit.edu/
16. Meylinda, M., Shahbodin, F., Pee, N.C. (2018). Malaysian higher education system towards industry 4.0 – current trend overview. *AIP Conference Proceedings, 2016*(1): 020081-1 - 020081-7. Available from: https://doi.org/10.1063/1.5055483
17. Oxford University Official Website. (2021). Available from: https://www.ox.ac.uk/
18. Pinheiro, R., Geschwind, L., Foss Hansen, H., Pulkkinen, K. (2019). London: Palgrave Macmillan.
19. Princeton University Official Website. (2021) Available from: https://www.princeton.edu/
20. QS Higher education system strength rankings (HESS). (2018). Available from: https://www.topuniversities.com/system -strength-rankings/2018
21. Sahaydak, I., Chorna, T., & Duma, N. (2020). The role of students' scientific work in the formation of safety culture and environmental awareness. In KS Varyvoda (Ed.), Proceedings of the X International scientific-practical Internet conference "Life safety, ecology and health of children and youth of the XXI century: current status, problems and perspectives" (pp. 78-87). Pereyaslav: Hryhory Skovoroda University.
22. Salvioni, D.M., Franzoni, S., Cassano, R. (2017). Sustainability in the higher education system: an opportunity to improve quality and image. *Sustainability, 9,* 914.
23. Schmaltz, R.M., Jansen, E., Wenckowski, N. (2017). Redefining Critical Thinking: Teaching Students to Think like Scientists. *Frontiers in Psychology, 8,* 459.
24. Sheikh, Y.A. (2017). Higher education in India: Challenges and opportunities. *Journal of Education and Practice, 8*(1), 39-42.
25. Siayah, S., Setiawan, A.R. (2020). *A brief explanation of science education.* Available from: https://www.researchgate.net/publication/340597990_A_Brief_Explanation_of_Science_Education/link/5e93cbfea6fdcca78911aa4f/download
26. Stanford University Official Website. (2021). Available from: https://www.stanford.edu/
27. Stella, M. (2020). Forma Mentis Networks reconstruct how Italian high schoolers and international STEM experts perceive teachers, students, scientists, and school. *Education and Science, 10*(17), 1–15.
28. Susantini, E., Kurniasari, I., Fauziah, A.N.M., Prastowo, T., Kholiq, A., Rosdiana, L. (2018). Engaging pre-service teachers to teach science contextually with scientific approach instructional video. In Abadi, A. Mustofa, SC Wibava (Eds.), IOP conference series: materials of science and engineering. Volume 296 (pp. 1-14). Bristol: IOP Publishing Ltd.
29. The world university rankings. 2021; Available from https://www.timeshignreduction.com/world-university-rankings/2021/world-ranking
30. Trigwell, K., Ashwin, P. (2003). Oxford student course experience questionnaire report. Undergraduate students' experience of learning at the University of Oxford. Oxford: Oxford University Press.
31. University of California, Berkeley, Official Website. (2021). Available from: https://www.berkeley.edu/
32. University of Chicago Official Website. (2021) Available from: https://www.uchicago.edu/
33. World Intellectual Property Organization. *Statistical country profiles.* (2019). Available from: https://www.wipo.int/ipstats/en/statistics/country_profile/
34. Yale University Official Website. (2021). Available from: https://www.yale.edu/
35. Yermachenko, V.Y., Derykhovska, V.I. (2017). Peculiarities of transformation of the world system of higher education in the XXI century. *Ekonomika i Suspilstvo, 10,* 516-522.
36. Zaim, M. (2017). Implementing scientific approach to teach English at senior high school in Indonesia. *Asian Social Science,13*(2), 33 – 40.

Primary Paper Section: A

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