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ASSESSING STUDENTS' READINESS TO RESEARCH ACTIVITIES USING THE HACKATHON ECOSYSTEM TOOLKIT

The article seeks to provide insights into the growing role of the research component within the higher education system as a key element in ensuring quality education and boosting student talent and potential. Given that modern society imposes new demands for a more skilled workforce, future professionals must demonstrate not only high-level professional competencies but also display well developed cognitive skills, independence, initiative and creative thinking. In the context of this study, a research competence is viewed as an integral personality trait which translates into the capacity and willingness to resolve research problems independently, mastering of research technology skills, recognition of the value of research and the ability to use it in the professional business settings. The dominant methodology of the study is to build a linear mathematical model that allows evaluating the readiness of student and post-graduates to conduct a research. The developed model provides the minimum, maximum and threshold values as well as diagnostic assessment indicators of the student readiness to perform research. In addition, the study presents a method to assess the readiness of student and post-graduates to research activities which was tested on the basis of the Hackathon Ecosystem of the Kyiv National University of Technologies and Design. The survey held has revealed the structure of a research competence that consists of ten main elements (competencies) of readiness of student and post-graduates to conduct research. Processing the results of the questionnaire has enabled to calculate the weight of each element, their mathematical expectation values, the density of probability distribution, and the average value of all the necessary characteristics for research. The calculation results have verified that the priority competencies of student and post-graduates are motivation to research and the level of academic training. University student and post-graduate engagement into research activities is an integral part of academic training to tackle professional issues. Within the study process, student research practices involve problem-based learning, a professional focus of training through a wide range of problem solving activities, as well as encouraging enhanced creativity. The findings demonstrate that making use of the University Hackathon ecosystem tools will contribute to identifying the students' and post-graduates' propensity to research activities, building relevant skills and abilities of research competence.

Keywords: *Hackathon ecosystem; readiness; research activities; students; university.*

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ДІАГНОСТИКА ЗА ДОПОМОГОЮ ІНСТРУМЕНТАРІЮ ХАКАТОН-ЕКОСИСТЕМИ ГОТОВНОСТІ СТУДЕНТСЬКОЇ МОЛОДІ ДО НАУКОВО-ДОСЛІДНОЇ ДІЯЛЬНОСТІ

Статтю присвячено аналізу зростаючої ролі науково-дослідної складової в системі вищої освіти як ключового компонента забезпечення якісної підготовки здобувачів та подальшого розвитку їх особистісного потенціалу. З огляду на те, що сучасне суспільство висуває нові вимоги до підготовки фахівців, майбутні спеціалісти мають демонструвати не лише високий рівень сформованості необхідних професійних компетенцій, але й розвинені навички пізнавальної діяльності, самостійність, ініціативність, а також творче мислення. У контексті цього дослідження, дослідницька компетентність розглядається як інтегральна якість особистості, що виражається в здібності та готовності до самостійного вирішення дослідницьких завдань, володінні

технологіями дослідницької діяльності, визнанні цінності дослідницьких умінь та здатності їх використовувати в професійній сфері. Основною методологією проведеного дослідження є розрахована лінійна математична модель, що дозволяє діагностувати готовність студентської та аспірантської молоді до науково-дослідної діяльності. Розроблена модель містить мінімальне, максимальне та порогове значення, а також індикатори діагностичних оцінок готовності студентської та аспірантської молоді до науково-дослідної діяльності. Розроблена методика діагностики готовності студентської та аспірантської молоді до науково-дослідної діяльності тестувалася на основі Хакатон-екосистеми Київського національного університету технологій та дизайну. Внаслідок проведеного анкетування виявлено структуру дослідницької компетентності, що складається з десяти основних компонентів (компетенцій) готовності студентської та аспірантської молоді до науково-дослідної діяльності. Обробка результатів анкетування дозволила обчислити вагові значення кожного компонента, їх математичне очікування, щільність розподілу ймовірностей, середнє значення з усіх необхідних для науково-дослідницької діяльності якостей. Результати розрахунків підтвердили, що пріоритетними компетенціями студентської та аспірантської молоді є мотивація до досліджень та рівень академічної підготовки. Участь здобувачів вищої освіти в науково-дослідній роботі є невід'ємною частиною підготовки майбутніх фахівців до вирішення професійних завдань. Науково-дослідна робота студентської та аспірантської молоді дозволяє застосовувати методи проблемного навчання, поглиблювати професійну спрямованість освіти завдяки розгляду проблемних ситуацій, готувати спеціалістів із підвищеним творчим потенціалом. Використання Хакатон-екосистеми університету дозволяє визначити схильність студентської та аспірантської молоді до науково-дослідної діяльності, сформувати необхідні вміння та навички дослідницької компетентності.

***Ключові слова**: Хакатон-екосистема; готовність; науково-дослідна діяльність; студентська молодь; університет.*

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ДИАГНОСТИКА С ПОМОЩЬЮ ИНСТРУМЕНТАРИЯ ХАКАТОН-ЭКОСИСТЕМЫ ГОТОВНОСТИ СТУДЕНЧЕСКОЙ МОЛОДЕЖИ К НАУЧНО-ИССЛЕДОВАТЕЛЬНОЙ ДЕЯТЕЛЬНОСТИ

Статья посвящена анализу растущей роли научно-исследовательской составляющей в системе высшего образования как ключевого компонента обеспечения качественной подготовки специалистов и дальнейшего развития их личностного потенциала. Учитывая, что современное общество выдвигает новые требования к профессиональному обучению, будущие специалисты должны демонстрировать не только высокий уровень сформированности необходимых профессиональных компетенций, но и навыки познавательной деятельности, самостоятельность, инициативность, а также творческое мышление. В контексте этого исследования, исследовательская компетентность рассматривается как интегральная характеристика личности, выражающаяся в способности и готовности к самостоятельному решению исследовательских задач, владению технологиями исследовательской деятельности, признании ценности исследовательских умений и способности их использовать в профессиональной сфере. Основной методологией проведённого исследования рассчитана линейная математическая модель, позволяющая диагностировать готовность студенческой и аспирантской молодёжи к научно-исследовательской деятельности. Разработанная модель содержит минимальное, максимальное и пороговое значение, а также индикаторы диагностических

оценок готовности студенческой и аспирантской молодёжи к научно-исследовательской деятельности. Разработанная методика диагностики готовности студенческой и аспирантской молодёжи к научно-исследовательской деятельности тестировалась на основе Хакатон-экосистемы Киевского национального университета технологий и дизайна. В результате проведённого анкетирования выявлена структура исследовательской компетентности, состоящая из десяти основных компонентов (компетенций) готовности студенческой и аспирантской молодёжи к научно-исследовательской деятельности. Обработка результатов анкетирования позволила вычислить весовые значения каждого компонента, их математическое ожидание, плотность распределения вероятностей, среднее значение всех необходимых для научно-исследовательской деятельности качеств. Результаты расчётов подтвердили, что приоритетными компетенциями студенческой и аспирантской молодёжи есть мотивация к исследованиям и уровень академической подготовки. Участие соискателей высшего образования в научно-исследовательской работе является неотъемлемой частью подготовки будущих специалистов к решению профессиональных задач. Научно-исследовательская работа студенческой и аспирантской молодёжи позволяет применять методы проблемного обучения, углублять профессиональную направленность образования, рассматривая проблемные ситуации, готовить специалистов с повышенным творческим потенциалом. Использование Хакатон-экосистем университета позволяет определить склонность студенческой и аспирантской молодёжи к научно-исследовательской деятельности, сформировать необходимые умения и навыки исследовательской компетентности.

Ключевые слова: *Хакатон-экосистема; готовность; научно-исследовательская деятельность; студенческая молодёжь; университет.*

INTRODUCTION

The modern competent paradigm of higher education development objectively focuses on the formation of future specialists' readiness for professional activity in conditions of high degree of uncertainty and dynamism of phenomena and processes. A person in the society should be ready to quickly solve qualitatively complex problems, be able to see and solve the problem, offering creative options. Research in a rapidly changing world is seen not only as a narrowly specialized activity of scientists, but also as an integral part of any activity, as a style of activity of a modern person. This means that one of the attributive characteristics of a specialist today is research competence.

Formation of students' research competence, as well as any other property of personality, requires, first of all, solving the question, which is a concept that defines its content and essence. In this regard, let us consider below the question of what is the essence and content of the concept of "research competence" in relation to students of higher education.

Following A. Stoltzfus, M. Rosenberg, H. Lapp, by diagnostics we mean "the process and ways of determining the degree of development of personal qualities, difficulties in learning, development, communication, mastering a profession, as well as efficiency of functioning and development of psychological systems, technologies, methods, pedagogical projects"[1].

Most of the works, which describe and disclose various aspects of students' research activities, are based on the competence approach and activity theory of N. Linnell, S. Figueira, N. Chintala [2].

Experiential competence is assumed to be both a system of research competences and the ability and readiness to apply them in practice. A detailed analysis of the literature on the set and content of research competencies can be found in D. Groen, B. Calderhead and other publications [2, 5].

Based on the previously made conclusions, it is reasonable to distinguish the following components of research competence of students:

- orientational, which includes goal setting, planning, forecasting and mastery of the methodology of scientific research;
- motivational, implying the determination of the importance of research activity for the individual;
- activity (substantive, operational, technological), consisting directly of research competences;
- reflexive.

The above-mentioned components are fundamental in the structure of research competence. However, it is possible to add other, also important constituent elements that determine the quality of students' research activity [6]:

- cognitive – a set of knowledge necessary for setting and solving research tasks in professional activity, erudition, the ability to obtain and assimilate new knowledge;
- information-instrumental – mastery of modern information technologies, the ability to collect and critically analyze information, the ability to effectively apply knowledge in practice;
- social-communicative – communication competences, in particular academic writing and presentation of a scientific text, foreign language competence, as well as ability to work in a team, find a common language with a scientific supervisor and colleagues [7].

In addition, the structure of scientific activities of undergraduates, graduate students and scientists may include [8]:

- innovation-implementation component – implementation and commercialization of developments, knowledge of the laws of economics, etc.
- creative-heuristic component – imagination, invention, freedom and independence of judgment [9].

The purpose of this article is to propose a model for diagnosing the readiness of student youth to research activities with the help of the University Hackathon Ecosystem Toolkit. The model was adapted in Kyiv National University of Technologies and Design in 2021.

Matherials and methods. Mathematical model to diagnose the degree of readiness of students of technical higher education to scientific research activity is presented in the form of a linear equation:

$$L = 5{,}66x_1 + 5{,}05x_2 + 2{,}05x_2 + 2{,}51x_5 + 2{,}88x_5 + 2{,}11x_6 + 2{,}68x_7 + 5{,}55x_8 + 2{,}88x_9 + 5{,}65x_{10}, \quad (1)$$

where $x_i = \{1; 2; 2\ldots\}$ are the values of competence levels (each of the ten competences is divided into three levels):

$L_{thr} = 2\sum_{i=1}^{10}\gamma_i$ – threshold (averaged) value of diagnostic assessment of student readiness for research activities;

γ_i – "weight" values of competencies (components) presented in Table 1; coefficient 2 – average level of components;

$L_{\max} = 3\sum_{i=1}^{10}\gamma_i$ – maximum value of diagnostic assessment;

$L_{\min} = \sum_{i=1}^{10}\gamma_i$ – the minimum value of diagnostic assessment.

The following indicators of assessment of student's readiness for research activities are acceptable:

L < 70 – below the average value of the student's assessment of readiness for research activities;

$70 \leq L \leq 80$ – the average value of the assessment of student's readiness for research activities;

$L > 80$ – above the average value of the student's readiness score for research activities.

The presented mathematical model is a tool for determining the readiness of students of technical universities for research activities. It is assumed that according to the results of the study a software product will be developed, the implementation of which will allow to determine the values of the linear function through testing. Then, based on the threshold values and test results, it will be possible to diagnose the students' readiness for research activities.

Results and discussion. In a direct dependence on the structure of research competence is the structure of readiness for research activities, which either partially duplicates some components, or can include them all with varying degrees of severity. M. Riesener, C. Dlle, M. Kuhn interpret students' readiness for research activity as "a personal formation determining the state of personality of the subject and including motivational and value attitude to this activity, system of methodological knowledge, permitting research skills to use them productively when solving professional and research tasks arising" [10]. The researcher gives the structure of students' readiness for research activities, the components of which coincide with the main components of research competence (Table 1).

Table 1

Structure of students' readiness for research activities

Component	Content
Motivational	Characterizes cognitive interest, motivation of research activity
Orientational	Include an understanding of the methodology of scientific research and the methods of research activities
Activity	Identifies the skills and abilities of research activities
Reflexive	Includes self-assessment and self-analysis of own research activity, definition of the ways of self-development in scientific cognition

The most essential competencies of a graduate student were found and ranked on a 5-point scale. In the course of the experiment 50 respondents from Ukrainian universities were interviewed. The methodology of selecting relevant qualities is described in detail in [11]. The most significant qualities highlighted by the researchers are presented in Table 2.

Table 2

The most important qualities of a graduate student

#	Qualities (competencies)	Percentage of responses with a score of 5
1	High level of academic training, erudition	98
2	Knowledge of foreign languages	90
3	Experience in working in an experienced group (team)	72
4	Experience in presenting research and development results	65
5	"Recognition in scientific environment, contacts in scientific community	65
6	Skills in writing competitive applications, grant applications	60
7	Familiarity with the basics of economics of science, methods of commercialization of research and development results	51

As can be seen from the content of Table 2, in addition to the research competences themselves, a young scientist should possess some communicative and economic competences

(items 2, 5–7), which defines a set of qualities required for a research student before entering graduate school or at the very beginning of his/her research career.

Based on the data of the survey and the structure of research competence, taking into account the difference between the level of training and experience in research activities of graduate students and students, the list of qualities required to assess the readiness of graduate students and students for research activities was formed. This list is somewhat extended in comparison with the filling of Table 1, as it includes some additional competences in addition to the main components of research activities.

The structure of students' readiness for research activity is represented by the following components:

- motivational;
- orientational;
- activitistic;
- reflexive;
- cognitive;
- informational;
- social and communicative;
- creative and heuristic.

This structure of readiness for research activities corresponds to the "extended" structure of research competence.

To determine the final set of qualities, as well as the weight of each of them in assessing the readiness of technical university students to research activities, we conducted a survey. There were 56 respondents who were candidates and doctors of science and had significant experience in scientific leadership. Among them were teaching professionals familiar with the specifics of students' research work and the peculiarities of the preparation of graduate qualification works.

The respondents were asked to answer two questions:

Evaluate the extent to which these qualities are necessary for a research student. Rate on a five-point scale from 1 (not essential) to 5 (absolutely essential).

The list of qualities needed by a research student is:

1) a high level of academic preparation, erudition;

2) complex approach to solving scientific and technical problems;

3) experience in working in a research group (team);

4) academic writing skills (including writing competitive applications, grant applications);

5) experience in presentation of research and development results;

6) knowledge of the basics of economics of science, methods of commercialization of the results of research and development;

7) proficiency in foreign languages;

8) knowledge of computer technologies, software products;

9) skills of professional reflection;

10) motivation of scientific research activity.

In your opinion, what other qualities, in addition to the above-mentioned competencies, are necessary?

In our opinion, it would be logical to start the analysis of the results of the survey with the second question, because the experts in their comments confirmed the expediency of enriching the structure of research competence and readiness for research activities. In particular, they proposed additions to the items listed in the first question:

to point. 1 – erudition:

- "a high level of secondary education in the exact sciences";

- "knowledge of the fundamental laws of exact sciences";
- "knowledge of the basic laws of philosophy";

to point. 2 – comprehensive approach to solving scientific and technical problems:

- "desire to learn and explore new things";
- "skills of planning research work";
- "ability to see the result of one's activity";
- "ability to systematically (comprehensively) consider the studied objects";
- "diligence";
- "ability to solve not only current problems, but also to work systematically, for the future";
- "quick reaction to changes in scientific knowledge on the researched subject and the ability to adapt in a new situation";

to point. 6 – knowledge of the basics of economics of science, methods of commercialization of research and development results:

- "fundamentals of project management";

to point. 9 – professional reflection skills:

- "analytical thinking (analytical skills)";
- "disposition to criticism and self-criticism, critical reflection on the results of one's activities";
- "ability for professional mobility";
- "knowledge of the current situation in a particular research field";
- "ability to navigate in related subject areas and be aimed at interdisciplinary synthesis".

Based on the expert assessment, the list of competencies presented in Table 2 was specified:

- "activity, independence": general activity, capacity for work, diligence, purposefulness, initiative, independence, ability to defend one's point of view, independence from the opinion of "recognized authorities";
- "creativity": scientific imagination, passion for creativity, curiosity, desire to understand the "zest" of the process, the ability to non-standard solutions, the ability to generate ideas and formulate a problem;
- "self-control, time management": the ability to organize one's time, self-organization to get work done, self-control, stress-resistance, ability to adapt quickly to changing conditions, punctuality, diligence, responsibility;
- "general communicative skills": interpersonal communication, ability to use technical literature and other sources, navigate modern information flows, select the necessary information and work with it.

These competencies can be considered as meta-competencies, which are core competencies and ensure the quality of basic research competencies. Taking into account these comments and the results of testing the proposed technology, further refinement and improvement of the proposed list of qualities is possible.

The analysis of the assessments given by the respondents when answering the first question made it possible to calculate the arithmetic mean of each item, i.e. to determine the weight coefficients (weight values of competencies) γi through statistical analysis to build a linear mathematical model of diagnosing the readiness of technical university students for research activities.

The obtained assessment values indicate that the list of components (competences) is correct, there are no insignificant ones among them. The component scores fall within the range [2.05; 4.67]: minimum value – $2.05 > 1$, maximum – $4.67 < 5$. The mathematical expectation (mean value) was 2.88. Component weights were: (2,88/5,0) – 100% = 57,6%.

Table 3 shows the values of the mathematical expectation, as well as the probability density of distribution for each quality – the proportion of evaluations of all respondents for each component.

Probability density of distribution is expressed by the ratio n/N, where n – number of hits, frequency of estimations from 1 to 5 for an individual competence; N – number of answers to the first question of the questionnaire (in items 1–8 – 56, in the last two items – 55 and 52 respectively).

In Table 2, the competencies are arranged in the same order in which they were presented to the expert community.

Table 3

Statistical analysis of respondents' answers

# in order	Qualities (competencies)	Mathematical expectation, γi	N	Probability density of estimates, n/N				
				1	2	3	4	5
1	High level of academic training	5,66	56	–	0,05	0,09	0,09	0,79
2	Comprehensive approach to solving scientific and technical problems	5,05	56	0,05	0,05	0,18	0,29	0,55
3	Experience in working in a research team	2,05	56	0,11	0,15	0,26	0,25	0,11
4	Academic writing skills	2,51	56	0,11	0,07	0,27	0,28	0,18
5	Experience in presenting research and development results	2,88	56	0,05	0,02	0,22	0,26	0,25
6	Familiarity with basic economics of science	2,11	56	0,18	0,07	0,26	0,25	0,15
7	Knowledge of foreign languages	2,68	56	0,02	0,16	0,21	0,2	0,2
8	Knowledge of computer technologies, software products	5,55	56	–	0,02	0,07	0,26	0,55
9	Skills of professional reflection	2,88	52	0,06	0,08	0,1	0,56	0,21
10	Research motivation	5,65	55	–	0,05	0,05	0,12	0,78

When comparing the data of Tables 2 and 3, it is found out that while the most important competences in R&D for PhD students are high level of academic training, erudition and knowledge of foreign languages, the priorities for research students of technical universities are somewhat different. In the formed for them list of necessary NICs the highest score was given to the high level of academic preparation (4.67) and motivation of research activity (4.66).

During the experiment the following indicators of assessment of student's readiness for research activities were confirmed:

$L < 70$ – below the average value of the student's readiness assessment for research activities;

$70 \leq L \leq 80$ – the average value of the student's readiness assessment to research activities;

$L > 80$ – above the average value of the assessment of student's readiness for research activities.

Thus, the developed mathematical model fully describes the readiness of students of technical universities to research activities.

Conclusion. The methodology of diagnostics of the readiness of students of technical higher education to research activities is proposed. In the course of the experiment the components of the readiness of a technical university student for research activities, their "weight" values, which served as the basis for creating a mathematical model that determines such readiness, were identified. This model can be the basis for creating a test software product that can be used in practice both by students to measure their propensity to research activities, and academic supervisors to correct the activities of undergraduate and graduate students.

The described diagnostic model is useful "at the entrance" of the students of a technical university for their orientation for further research activities. From our point of view, further promising directions of research and development of the system of research activities of students and graduate students are:

- analysis of the importance of basic training of research students and postgraduate research students from the point of view of academic supervisors and students themselves (experiment);
- study of the possibility of supporting the research activities of undergraduate and graduate students depending on the value of the indicator assessment of student's readiness for research activities (tutoring in the field of research activities);
- development of a mathematical model of success (effectiveness) of research activities of undergraduate and graduate students "at the output" and its correlation with the psychological competence of the research supervisor.

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