Scientific E-conference as a Tool of Development Students Research Competence: Local Study

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Abstract. The article considers the competence approach to the formation and development of university students' research competences by means of scientific e-conferences. It analyzes the concept and structure of research competences. It establishes the compliance of the developed competences with the ISTE 2016 standard for students. It offers the indicators of measuring the acquired research competences. The present article also substantiates the efficiency of the scientific e-conferences use as an instrument for the development of students' research competences.

Keywords: E-conference, Research Competences, Standard, Open Conference Systems, Education.

1 Introduction

The key factors of changes in the educational environment of recent decades are the formation of a global knowledge economy, which comprises such features as increasing importance of high technologies and knowledge-intensive industries as well as widespread informatization. In connection with this, there arises the need for integration of education and science at the institutional, regional, and global level, since the scientific activity itself is the generator of scientific knowledge and the basis of innovation development.

The basis of meaningful changes in ensuring the compliance of education with the needs and opportunities of the society is the concept of competence approach in education [1]. Solving the problem of the integration of university education and science requires the identification and formation of special competences [2] of the participants in the educational process: both students and teachers. The emphasis on dialogue and collaboration, information technologies, which are increasingly used in the educational process of higher education, give rise to new approaches to educators and to existing forms of research. The transfer of tools and forms of scientific communication into the online space and the development of open science, which includes open data, open research, open communication, contribute to the formation of research and competences for Information and Communication Technology (ICT) Literacy [3].

Partial decisions on the training of a competent researcher in university education, which are often the subject of study of specialists in various subject areas, usually

contain a quantitative assessment of the measurement of individual competences. Qualitative comprehensive assessment of the level of competence acquisition requires additional research.

The goal of the article is to find out the role of students' scientific conferences in shaping the research competence of a future specialist while applying the system of information support.

The research was carried out in the National University of Life and Environmental Sciences (NULES) of Ukraine during 2013-2017 within the framework of holding annual e-supported conferences of young scholars (for example, http://econference.nubip.edu.ua/index.php/itete/VIII/index).

2 Literature Review

The students' research work is an important component of the scientific activity of a higher educational institution and an important factor in training qualified specialists.

T. Subahan Mohd Meerah et al. with the aim of measuring the students' research skills single out such groups [4]: methodology, information seeking, problem solving, statistical analysis, communication. The instrument to measure research skills is submitted in [5].

According to A. Sirkka and J. Cap, scientific or research competence consist of various skills required to question, assess and evaluate critically, to develop scientific, research and instrumentation, organization skills to systematically collect, analyze and interpret data, to design experimental settings, to communicate in terms of scientific writing and oral presentations, and to collaborate with other actors [6].

F. Bottcher and F. Thiel have developed a research competence model, which comprises five dimensions: skills in reviewing the state of research, methodological skills, skills in reflecting on research findings, communication skills, and content knowledge [7].

Research competence are defined as the ones that enable students to analyze a given topic or subject in a structured, research-based way, often following the systematic steps in a research project [8]. The development of the student's research competence is more effective while applying mixed learning [9] and research practice [10]. The latter one often happens in the surrounding of research associations with different universities and companies.

Students aiming for a career in research and development realize at early stages that success depends not only on getting academic credentials but also on the quantity and quality of their contributions to knowledge. The most accessible way for students to get recognition for their contributions is to participate in a conference and present their findings (e.g., http://www.unica-network.eu/event/unica-student-conference-2017). The advantages of students' participation in conferences are discussed at the forums (e.g., http://blogs.plos.org/thestudentblog/2014/02/24/every-science-student-should-attend-conference/).

Many universities hold their own conference each year to celebrate the research accomplishments of their undergraduate students. They are often a place for students

to present their Honors thesis project. There are also many regional and international conferences. In such cases students have more possibilities to explore the leading edge of the discipline; establishing connections in the scientific community can be of huge benefit for an undergraduate interested in embarking on a scientific career. This can help students to identify potential mentors, projects, laboratories, and institutions that they would like to work with/for in the future.

But not every student has an opportunity, first of all financially, to participate in professional scientific conferences. A partial solution to this problem is through the development of scientific online communication, in particular, conducting e-conferences [11, pp. 26-28]. The experience review of using e-conferences in higher educational institutions (HEIs) will update the following areas of research:

- the connection between asynchronous, text forms of social communication and students' perceptions of the social climate of computer conferences [14, 15]. Moderators are encouraged to seek a balance between social communications and integrated and productive discussions;
- the choice of software from a large number of tools [16] – the researches recommend the conference organizers to use available open source for efficient management of scholarly publishing activities, such as electronic acceptance of papers and abstracts, peer review of submitted papers, participants' registration, post conference proceedings and posting papers in a searchable format, and other tasks of conference management [11];
- the correlation between the participants' ICT digital literacy [12] and the quality of holding a conference. It is expected, that the participation in e-conferences promotes the development of ICT digital literacy by its participants on condition that at least 50% have Below Average level [13].

3 E-conference: Instructional Design and Realization

The student's preparation and participation in the scientific conference (Fig. 1), in our opinion, is a complex solution, which demonstrates the level of acquiring the research competences. By presenting their reports at a conference, students can gain soft-skills that will be valuable at every level of their academic careers. Students participating in a poster presentation or review must prepare a visual representation of their work and present the summary of their findings clearly and concisely to other attendees. The performance-making process requires students to organize their data and to delve into science writing at a deeper level than allowed by class lab reports. Many undergraduate science symposiums pair presenters with scientist judges who have some degree of expertise on the topic at hand. This requires the student to be well versed on the paradigms and the methods used in his or her field. The entire process of preparing and presenting a poster necessitates a significant amount of sustained effort and helps students-researchers to internalize their research and to build skills that will be useful in future.

The students in the process of preparation and participation in the conference perform the following tasks: define the subject of the report and submit it to the scientific

advisor for approval; prepare the paper (thesis, article); check for plagiarism; submit for expert evaluation; elaborate; prepare the findings in the form of presentation; participate in the conference. These tasks can be grouped into 2 stages 1) preparation of paper; 2) presentation of the findings. At each stage, when performing certain activities, students acquire professional, research, information and communication competences.

The scheme of building students' research competences and their compliance with the sections of the ISTE 2016 standard is shown in Fig. 1. In particular, at each stage of the student's participation in the scientific e-conference, we will define opportunities for the formation and development of research competences. In this study, the following components of research competences are used [4, 5]: methodology skills, information seeking skills, problem solving skills, quantitative analysis skills, communication skills.

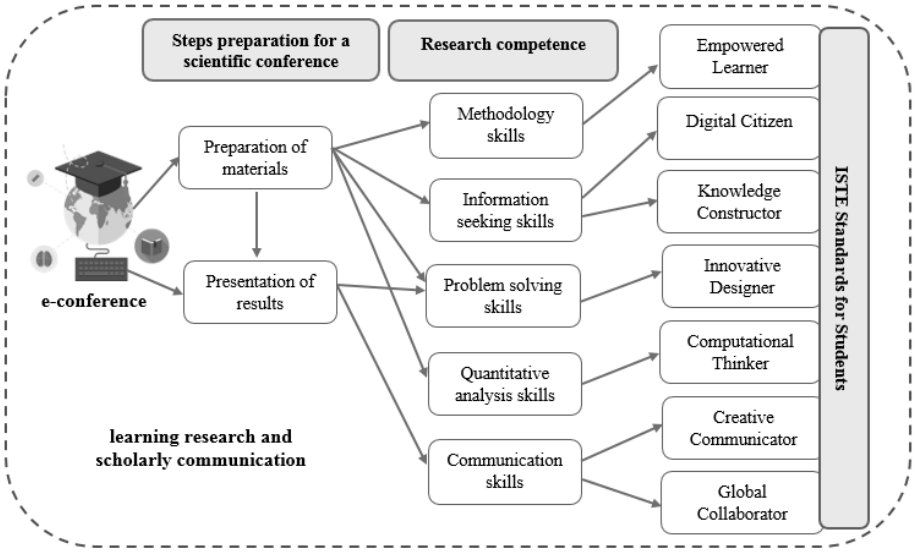

Fig. 1. The scheme of building students' research competence and their compliance with the sections of the ISTE 2016 standard (Source: Own work)

The skills that are part of the research competence structure and can be developed as a result of the student's participation in scientific e-conferences fully correspond to the "Education technology standards to transform learning and teaching (ISTE)". In particular, the definition of competences for students, their features and measurement indicators are given in [17]. This standard includes 7 components: 1) Empowered learner; 2) Digital citizen; 3) Knowledge Constructor; 4) Innovative; 5) Computational; 6) Creative Communicator; 7) Global Collaborator.

Table 1 defines in more detail the types of activities in the course of which the student develops his research competence, as well as standard indicators for students according to which it is possible to measure the level of achieving the research com-

petence by the student for each of the above-mentioned tasks of the student's two-stage participation in the e-conference.

Table 1. The development of student's research competence in the process of preparation for the scientific conference

Task content	Activity	Components of research activities	ISTE standards and their indicators for the students
Stage 1. Material preparation			
Formulation of the problem (according to the line of research)	- the choice of the topic; - formulation of the title; - definition of the goal, methodology of research and ways of solving the problem	- methodology skills; - information seeking skills; - quantitative analysis skills	1. Empowered Learner: 1A. 3. Knowledge Constructor: 3A. 5. Computational Thinker: 5A.
Definition of the type of scientific paper and familiarization with the requirements for its preparation	- definition of paper structure; - drawing up a plan; - selection of necessary sources of information; - choice of methods and argumentation of necessity and specificity of their use	information seeking skills; problem solving skills; methodology skills	3. Knowledge Constructor: 3A., 3B., 3C. 4. Innovative Designer: 4A. 5. Computational Thinker: 5B.
Creation of an academic paper according to the line of research (theses, scientific article)	- comparison of the data obtained during the study; - formulation of conclusions, data consolidation and generalization - preparation of the academic paper in accordance with the requirements of the conference	problem solving skills; quantitative analysis skills	4. Innovative Designer: 4D. 5. Computational Thinker: 5C. 2. Digital citizen: 2A., 2C.
Reviewing and editing an academic paper	sending a prepared paper; receiving reviewers' comments; communicating with the editor (reviewer); making a decision on introducing changes to the work	- information seeking skills; - communication skills; - problem solving skills	2. Digital citizen: 2A., 2B. 7. Global Colaborator: 7B., 7D.
Tools: communication (Outlook, Calendar, Skype, Meet, Hangouts), collaboration (One Drive, Google Drive, OneNote), cooperation (Forms, Planner), statistical data analysis (MS Excel, SPSS, PowerBI), platforms supporting scientific conferences (Open Conference Systems)			

International abstract and citation database: Web of Science, Scopus, EBSCO, Google Scholar			
Stage 2. Results presenting			
Preparation of the presentation (poster) of the speech based on the submitted academic paper	Elaboration of the speech structure and preparation of the visual demonstration in line with the requirements of the target audience	problem solving skills; communication skills	5. Computational Thinker: 5C. 6. Creative Communicator: 6C, 6D.
Tools: Cacoo, Mindomo, Power Point, Sway, Prezi, Google Presentations, Piktochart, Canva, Calameo, Youtube, Stream; platforms supporting scientific conferences (Open Conference Systems)			

Based on the analysis of publications on the management of online conferences [19], as well as on the use of online platforms for conducting student conferences [18], Open Conference Systems (OCS) – an open source software produced by multi-university Initiative Public Knowledge Project – was chosen in the NULES of Ukraine (https://web.stanford.edu/group/publicknowledge/cgi-bin/pkdrupal/about). OCS is a free web publishing tool that helps in creating a complete web presence for scholarly conferences, an integrated tool for creating a conference website, sending call for papers, electronically accepting paper and abstract submissions, posting conference proceedings and papers in a searchable format, editing papers after peer review, and registering conference participants and allowing post-conference online discussions, besides many other functions helpful to conference organizers.

The Open Conference Systems platform can support multiple conferences, and each conference. All conferences have unique URLs, as well as their own design (e.g., http://econference.nubip.edu.ua/index.php/itete/VIII/index). The system of settings allows you to assign both a single conference leader and a team for various conference calls (Table 2).

Table 2. Functions of performers in Open Conference Systems platform

Role	Functions
Site Administrator	− creating an e-conference on the site; − access policy setting; − setting up the registration of participants and assigning access according to the role distribution; − setting timing for submission of materials; − establishing types of presentation of materials; − configuring indexing options, commenting; − placing links to an e-conference on various blogs, communities, sites; − feedback setting; − configuring access to archive materials of the e-conference and commenting capabilities;

	− export list of registered persons;
Conference Organizer	− definition of conditions and format of participation; − definition of terms of submission and forms of presentation of materials; − definition of the rules of registration of participants; − definition of section moderators and reviewers
Author	− registration at the conference as an author; − loading of materials to the site (abstracts, article, presentation, poster); − making corrections after reviewing
Moderator	− appointment of reviewers according to the chosen section and the submitted material; − communication with the author and reviewer; − notification of the results of consideration of materials; − provision of the status of the submitted materials: "accepted for publication", "rejected", "recommended for revision"
Reviewer	− communication with the moderator; − reviewing the submitted materials
Participant	− registration at the conference as a participant; − commentary on performances; − review of conference materials
Reader	− search and view e-conference materials (depending on access policy)

Educators of an educational establishment or young scientists with experience in the organization of scientific conferences may be moderators of an e-conference. As reviewers can serve professionals (preferably independent) relevant to the conference. The section moderator communicates with the author of the submitted materials directly through the mailing, using the conference site, and the reviewer indirectly (through the moderator of the section), because the blind review is used.

At each stage of the preparation and participation in the e-conference the students, lecturers and experts (reviewers) cooperate in such a way as to form not only students' research competences, but also competences for ICT Literacy. Using the platform of online conferences (Fig. 2) it is possible to review the theses (2) downloaded by the students (1), to accomplish the expert assessment (3), placement (4), viewing and discussion of presentations. For other tasks it is possible to use other instruments (Table 1).

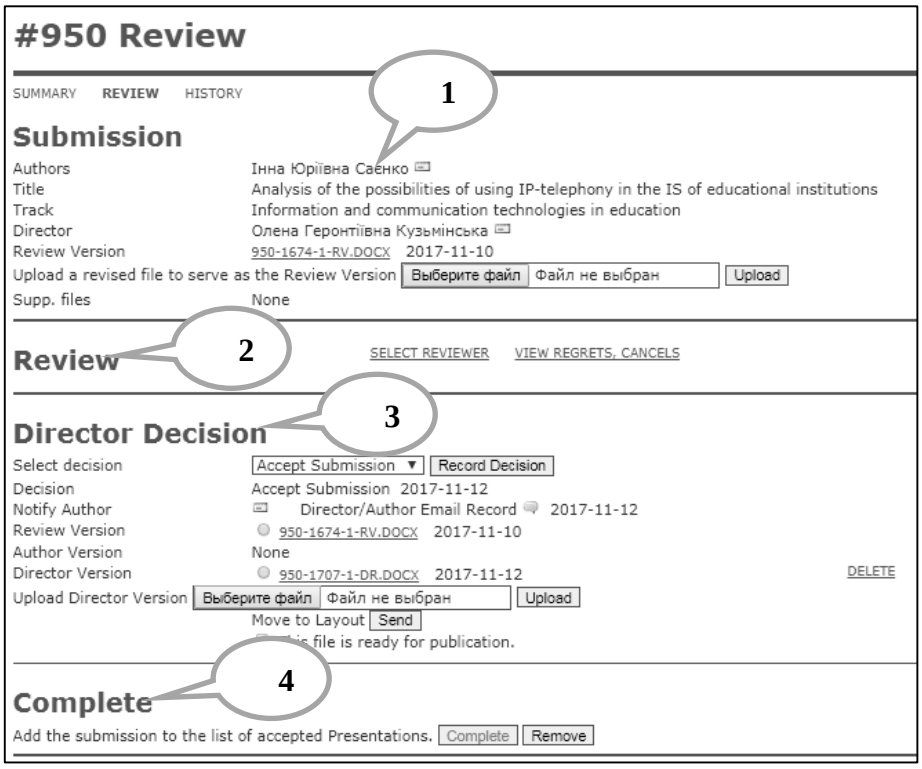

Fig. 2. An example of submitting the paper by using e-conference

4 Research Outcomes: Organization of Pedagogical Experiment, Indicators of Research Competence Measurement, Statistical Analysis

In the course of the research, a hypothesis was made that the systematic use of scientific e-conferences in the students' learning process at the University is an effective means of developing their research competence.

The research was carried out within 3 years. Students of the Faculty of Information Technologies of NULES of Ukraine were involved in the pedagogical experiment. Students of experimental groups during their training in 3, 4 and 5 years of study within the framework of the defined academic discipline were required to prepare a research paper and take part in the scientific e-conference, which was held at their Faculty (e.g., http://econference.nubip.edu.ua/index.php/itete/VIII, http://econference.nubip.edu.ua/index.php/grpi/grpi17). Thus, each student of the experimental group during 3 years of study participated in at least 3 scientific conferences. Preparation for the conference and findings of the carried out research were completed in line with the above-mentioned methods. The participation in scientific e-conferences wasn't obligatory for the students of control groups.

Questionnaires, based on previously identified research competence indicators, were developed to measure the achievement by a student of a certain level of research competence [5]. These questionnaires were used to evaluate Faculty Masters' poster sessions of the scientific conference. Out of 88 students, who submitted their diploma projects, 44 students were from the control group and 44 – from the experimental one. The examining board, consisting of professors and associate professors of the faculty, evaluated the conducted research and its presentation according to the indicators that characterize the level of research competence development by Masters. Table 3 offers examples of indicators for structural components of research competence. The 10-point scale was used to assess the achievement level of the corresponding indicator.

Table 3. Indicators for measuring research competence

Component	Indicator of research competence	Scale
Methodology (M)	M1. Understands the content of the research stages	1…10
	M2. Correctly applies research methods	1…10
	M3. Is able to substantiate methodological approaches to the research	1…10
	M4. Understands the notion of the experimental data samples	1…10
	M5. Is able to determine the hypothesis of the study, subject and object of the study	1…10
Information seeking (I)	I1. Is able to effectively seek materials on the topic of research	1…10
	I2. Uses abstract and citation database for information search	1…10
	I3. Is able to analyze and critically evaluate materials from a variety of sources	1…10
	I4. Correctly cites information sources	1…10
Problem solving (P)	P1. Is able to define the research problem and tasks for solving it	1…10
	P2. Is able to evaluate problem solving options and choose the most effective one	1…10
	P3. Can offer a new way to solve the problem	1…10
	P4. Demonstrates analytical skills to examine the consequences of a particular solution, and reasoning skills to weigh one solution against another	1…10
	P5. Demonstrates the skills of imagination and creativity while addressing the research problem	1…10
	P6. Is able to conduct scientific experiments	1…10
Quantitative analysis (Q)	Q1. Is able to carry out data collection procedures involving planning and selecting appropriate data collecting tools or instruments	1…10
	Q2. Identifies an appropriate method (quantitative and qualitative) for interpreting and manipulating data and	1…10

	Q3. Applies appropriate statistical tools for testing the research significance in addition to understanding	1…10
	Q4. Realizes limitations of analysis techniques (for example, understands the assumptions behind a statistical analysis, and examines whether your data fit these assumptions) and	1…10
	Q5. Draws and interprets appropriately the conclusions from results of analysis	1…10
Communication (C)	C1. Is able to write and present the research and its findings	1…10
	C2. Can communicate to others the purpose and outcomes of the research	1…10
	C3. Is able to summarize information, explain the purpose, objectives, conclusions of the research	1…10
	C4. Can tailor the communication to the needs and knowledge level of a particular audience	1…10

All the students from experimental and control groups were assessed on each indicator. The mean value for all indicators was taken to form the contingency table. The clustering of values was carried out on such principle: students who received an average score of 0 to 4 have a low level of research competence, from 5 to 8 – the average one, 9 and 10 – the high level respectively. Thus, the results of 3-level research competence assessment, depending on the group of students, are compiled in Table 4. It also includes the expected frequencies, provided that there are no differences between the levels of research competence in the experimental and control groups. As we can see from the analysis of the table data, the actual levels of students' research competence differ significantly from the theoretical ones: for the experimental group, the actual value of the research competence is higher than expected and vice versa.

Table 4. The contingency table of research competence levels depending on the group of students

			Levels of research competence			Total
			low	average	high	
Groups	CG	Frequency	22	16	6	44
		Expected frequency	16,5	18,5	9,0	44,0
	EG	Frequency	11	21	12	44
		Expected frequency	16,5	18,5	9,0	44,0
Total		Frequency	33	37	18	88
		Expected frequency	33,0	37,0	18,0	88,0

For statistical confirmation of the assumption that the levels of research competence differ in groups, it was offered to use the Pearson's $\chi 2$ criterion as variables belong to categorical and ordinal data types, and the Student's criterion, since it is possible to estimate the hypothesis of the equality of the mean values of two sets, in our case the means of research competence in training groups.

To test the first assumption, we formulated the null hypothesis: the use of e-scientific conferences does not affect the level of research competence, that is, the existing changes in the variable RC (research competence) are random. It was followed by the corresponding calculation, the results of which are given in Tables 5 and Fig. 3.

According to the results of calculations (Table 5), the empirical value of $\chi 2$ is greater than critical for (2-1) * (3-1) = 2 degrees of freedom: 6,342> 5.991, which also indicates the value of asymptotic value, which determines the probability of error in the rejection of null hypothesis. Consequently, we adopt the alternative hypothesis: the systematic use of e-scientific conferences affects the level of research competence, that is, existing changes in the RC variable are non-random.

Table 5. $\chi 2$ criteria

	Values	Degrees of freedom	Asymptotic value (bilateral)
Pearson's chi-squared test	6,342	2	,042
Relation of plausibility	6,454	2	,040
Linear-linear connection	5,898	1	,015
Number of valid observations	88		

Visually this is seen from a clustered diagram (Fig. 4), where we observe an increase in the level of research competence, depending on the systematic use of scientific e-conferences in the educational process.

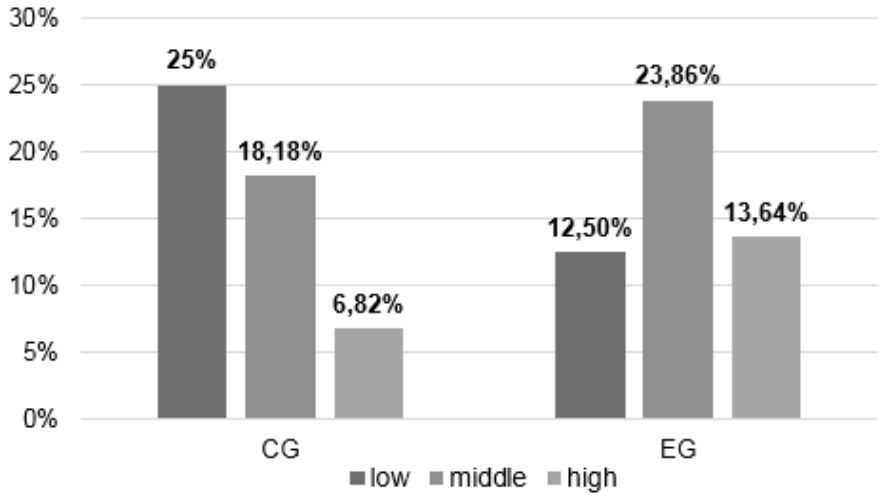

Fig. 3. Clustered diagram of research competence levels distribution in control and experimental groups

As we see from Table 6 sample mean for the control group is 5.0 points, and for the experimental group – is 6.32 (Table 6). However, to validate the differences in the

sample mean for the general population, we use Student's criterion for independent samples. The actual value of t-statistics of the mean deviation is 2.415 (Table 7) with a critical tcg = 1.988.

Table 6. Group statistics

	Group	Quantity	Mean	Student's deviation	Student's error of the mean
Points	CG	44	5,00	2,597	0,392
	EG	44	6,32	2,522	0,380

Table 7. T-criterion of means equality

t	Degrees of freedom.	Value (bilateral)	Means difference	Student's error of the difference	95% confidence interval of difference of means	
					Lower bound	Upper bound
-2,415	86	,018	-1,318	,546	-2,403	-,233

Consequently, the hypothesis of means equality was not confirmed. Accordingly, there is a statistical difference between the mean values of the points in two groups, which indicates that for the experimental group, the mean score of the assessment on indicators of research competence is 1,318 higher than in the control group.

Thus, the hypothesis, that the systematic use of scientific e-conferences in the educational process of university students is an effective means of developing their research competence, is confirmed by the results of the pedagogical experiment and their statistical analysis.

Along with the assessment of the level of the student's research competence formation, a survey in experimental students groups was conducted according to the following three blocks of questions:

1. Personal data of the participants, in particular, the number of conferences in which the student participated, and the evaluation of the effectiveness (determining the degree of performance by a 10-point scale);

2. Evaluation of the impact of participation in scientific e-conferences on the formation of research competence individual components (the impact of each component was evaluated on a scale from 0 to 10);

3. Assessment of the influence of informational support of conferences on the formation of components of digital literacy (the development of each category of skills was assessed on a 10-point scale before and after the experiment).

Based on the analysis of the survey results, we can draw the following conclusions:

1. A student, who participated in scientific conferences each year, has a higher level of research competence (75% of students who demonstrated high and intermediate level of research competence, participated in 4 or more academic conferences).

2. Participation in the preparation of materials and presentation of research results at scientific conferences with the help of the OCS system promotes, first of all, the development of such components of research competence: Information seeking (I3),

Problem solving (P2, P4), Quantitative analysis (Q5) and Communication (C 1 -C 4) (fig. 4).

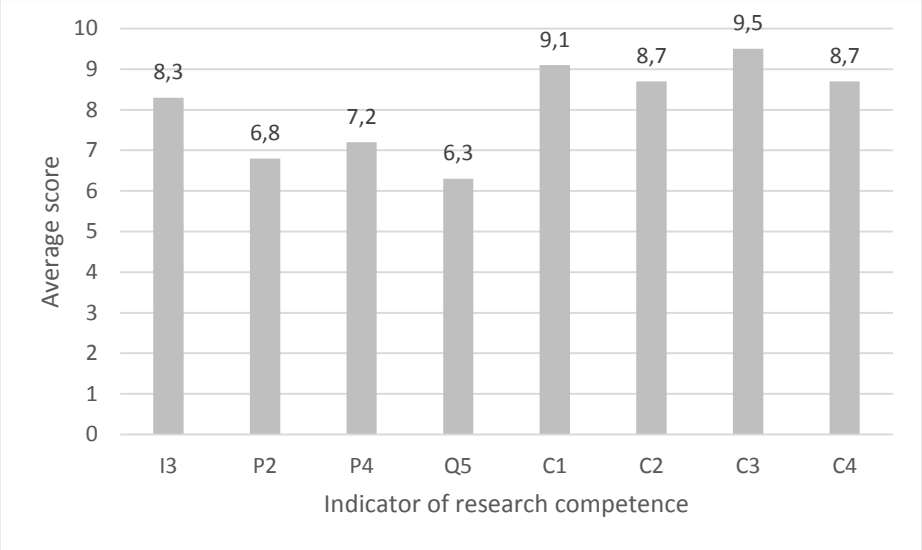

Fig. 4. Diagram of the influence of students' participation in scientific e-conferences on the development of research competence components (based on students' self-assessment)

3. According to questionnaire results, students identified the positive impact of participation in e-conferences on the development of foundational skills of ICT literacy. 85% of the respondents confirmed the increase of personal access skills, 25% – management skills, 73% – integration skills, 60% – evaluative skills, 57% –creative skills and 90% –communicative skills.

5 Conclusions

Research conferences for undergraduates give learners the opportunity to engage in formal and informal learning environments which promote their ability to engage actively and creatively in learning, research and professional communities both within and beyond the institution.

When performing each stage of preparation for participation in a scientific conference, the student finds, analyzes professional-oriented materials, searches for the optimal solution of the problem, learns to substantiate, refute false thoughts, search and analyze information, construct new knowledge and present the results of his own research and to conduct a scientific discussion. In this way, students' research competences are formed. The indicators suggested in the research for measuring research competences are an effective tool for measuring the student's achievement of the corresponding components of research competence. As a result of a three-year pedagogical experiment, students who systematically participated in scientific e-conferences demonstrated more advanced research competences while performing their Master's

research papers. Moreover, the use of the platform as information support for holding e-conferences creates opportunities for equal access of students to conferences and contributes to the development of ICT literacy.

The preparation and participation in the conference covers almost all the requirements of the ISTE 2016 standard for students. This suggests that the approach, which has now been implemented in the form of systematic use of the e-scientific conferencing tool for the preparation of papers using the e-system of support for scientific conferences, takes into account, as far as possible, the requirements for the preparation of students at universities in accordance with European standards, and will make future specialists more competitive on the domestic and foreign labor market, will expand the vision and perception of the surrounding reality as of an open information system. Students also have an opportunity to explore the leading edge of the discipline, while making connections in the scientific community can be of huge benefit for an undergraduate interested in embarking on a scientific career.

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