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BIBLIOMETRIC ANALYSIS IN DETERMINING THE RESEARCH DIRECTIONS OF EARLY CAREER RESEARCHERS

Abstract. The paper offers an overview of publications on the use of bibliometric analysis in various scientific studies. It was found out that the use of the scientific mapping tool to carry out such analysis at the stage of identifying early career scientists' research directions has not been previously explored. A sample statistical survey of 68 supervisors of Master's research from the National University of Life and Environmental Sciences of Ukraine and Ternopil Volodymyr Hnatiuk National Pedagogical University revealed that research supervisors with little experience, as well as supervisors in the field of social sciences and the humanities, lag behind in the use of channels and tools of modern digital scholarly communications. It is suggested that the use of built-in tools of bibliometric systems for systematic analysis aimed at determining the directions of Master's research will contribute to the quality of Master's theses, and hence to the development of university science in the context of its integration into the global research space. The authors propose a case of applying scientific mapping for the queries for search of scientific publications in Scopus and Web of Science (WOS) scientometric databases, based on the research areas of the Department of Informatics and Methods of Its Teaching of Ternopil Volodymyr Hnatiuk National Pedagogical University. The paper describes approaches to the use of VOSviewer to produce terminological maps based on concepts occurring in the titles, keywords and abstracts of the relevant sets of scientific publications. Since the Department offers Master's programs for students majoring both in Education/Pedagogy (014 Secondary Education (Informatics)) and Information Technology (122 Computer Science), on the basis of the analysis of links in thesauri from the Web of Science and Scopus data sets the authors identified research directions and provided examples of research themes for Master's theses majoring in Educational Technology and Information Technology, respectively. The results of the conducted survey and in-depth interviews with Master's students' research supervisors showed the expediency of expanding the pedagogical experiment aimed at the development of the methods of systematic literature review at various stages of working on a Master's thesis, involving the use of a wide range of bibliographic analysis tools. The results presented in the paper can be useful both for early career researchers and their research supervisors.

Keywords: bibliometric analysis; bibliometric science mapping; early career researchers; Master's thesis; review, high education.

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1. INTRODUCTION

Statement problem. The research potential of higher education institutions is commonly linked to the research output of their academic staff. Early career scientists can not only rapidly integrate into the common research space, but also become catalysts for the development of science both at the level of their educational institution and their country and at the level of individual reseach, provided that there exist strong institutional scientific schools and well-developed digital educational [1] and scientific environments focusing on digitalization of research and communication [2], and on condition that these researchers are fully involved in the implementation of relevant scientific projects, including international ones, and in specialized training [3]. It should be noted that most studies define early career scientists/researchers as PhD students [4, 5], but research for Master's degrees [6] and the formation of Master's students' research competencies [7, 8] have not received sufficient attention.

Formation of students' research competencies is an essential component of Master's programs, which is above all realized in the process of carrying out actual research and scientific communication [9]. Formation of these competencies in the process of studying specific academic courses is less effective [4]. In this context, the issues related to choosing research topics and substantiation of research directions of early career scientists in general, and Master's students in particular, come to the foreground. Here, the leading role obviously belongs to research supervisors, who have a decisive voice in choosing their students' research topics, setting research goals and selecting methods and tools for attaining them.

Bibliometric analysis is a tool for studying research output (knowledge) in general and the results of scientific communication in particular [10]. According to the authors, the results of such analysis can be used both in assessing the impact of research and authors on the development of science, and in the process of choosing research directions for early career scientists. Therefore, the problem of the use of bibliometric analysis to identify early career scientists' research directions calls for a detailed study and development of adequate approaches and methods to address it.

Analysis of the recent research and publications. Today, bibliometric analysis as an approach to systematic review which uses descriptive statistics when comparing scientific literature in a particular field [11] is quite widely used. For instance, Carmen Rodríguez Jiménez et al. use bibliometric analysis to study the development of educational technologies in higher education based on the relevant research output contained in the Web of Science database [12]. The relevance of this issue is confirmed by the fact that in 2021 researchers from Turkey also carried out a trend study of educational technologies via bibliographic mapping, using VOSviewer as a bibliographic mapping tool [13].

The experience of using bibliometric analysis to assess the impact of scientific journal publications is presented in [14]. For their analysis, the German researchers used publishers' information, as well as reference data (such as citations and authors' geographic location) from the Web of Science. Another example of the use of bibliometric analysis to facilitate the development of science is given in [15]. The authors used specialized software (Pajek – to edit graphs and visualize the graphical structure of co-authorship using Kamada-Kawai method, and VOSviewer – to create network maps) to monitor the implementation of the international research project IRNet.

An analysis of research in a specific subject area (in this case, evolution of waste recycling research) by means of Clusterization and Mapping is offered in [16]; bibliometric analysis for performance measurement in business, management and accounting subject area is used in [17], bibliometric analysis in Industry 4.0 – in [18]. J. B. Alvarado et al. presented pros and cons of the different analysis methods, and a review of the corresponding tools [18]. In the context of

our study, of particular value is the substantiation of the use of VOSviewer for Keyword co-occurrence analysis and Science Mapping / Network analysis, and Scopus and the WoS as academic databases.

The choice of a publication database and tools for applying various methods of bibliometric analysis depends not only on the goals of a particular research, but is also guided by the specifics of using bibliometrics in different research areas. Thus, S. Nazarovets in [19] presented a comprehensive analysis of the specifics of using bibliometrics in social sciences and the humanities in comparison with the natural sciences. The specificity is explained by the fact that researchers in social sciences and the humanities actively use in their research various languages, types of publications and citation practices. In addition, it should be borne in mind that publishing behavior in non-native English-speaking European countries does not only depend on the field of research but is also closely linked to the country's cultural and historical heritage [20]. This fact should also be taken into account when identifying research directions in a particular field in the process of formulating early career scientists' research tasks.

With few, as it is, papers on the use of bibliometric analysis in general [21], and Scientific Mapping in particular [22], to examine the characteristics and topical foci of early career scientists' studies, we have not found any comprehensive works featuring the use of bibliometric analysis at the stage of identifying early career scientists' research directions.

To fill this gap, the **purpose of this paper** is to analyze research trends related to the research areas of a particular academic department, by conducting bibliometric and network analysis. We also aim to make a new contribution by developing the methods of applying bibliometric analysis to determine Master's students' research directions.

Objectives of the study:

1. To determine the position of Master's students' research supervisors in Ukraine's institutions of higher education on keeping their students' research directions in various research areas up-to-date and relevant.

2. To develop the methods of applying bibliometric analysis to determine Master's students' research directions and verify the expediency of its use (from the standpoint of Master's theses supervisors), with the aim of raising the quality preparation of Master's research and contributing to the development of university science in the context of its integration into global research space.

2. RESEARCH METHODOLOGY

The primary basis of our research is methodological foundations of literature review process as a research method [23], and the experience of using VOSviewer for science mapping [15].

To identify the approaches to the choice and substantiation of early career scientists' research directions, in our case the topics of Master's theses (research objective 1), we used a sample statistical survey as one of the methods of monitoring and evaluating the effectiveness of educational projects according to J. Tames and J. Miller [24].

In view of the leading role of research supervisors, we developed an electronic form (https://forms.gle/k1BU2AkhV4jKgKFYA) and conducted a survey among academic staff of two higher education institutions in Ukraine. This being the first study of such kind, it involved a relatively small number of respondents, 68 academics from National University of Life and Environmental Sciences of Ukraine and Ternopil Volodymyr Hnatiuk National Pedagogical University, which somewhat limits the scope of the study. Nevertheless, the survey sample gives the possibility to draw certain conclusions about existing trends and patterns, and can be expanded, if required, in further pedagogical experiments. The analysis of the contextual characteristics of the survey participants shows an even distribution of the sample population

in terms of the areas of the respondents' research (30.9% of the respondents represent natural sciences; 35.3% – technical sciences; 33.8% – social sciences and the humanities) and their experience in supervising Master's theses (52.9% of the respondents are experienced supervisors, i.e. they have been acting in this capacity for more than 10 years; 23.5% have from 5 to 10 years of such experience; 23.6% have the experience of up to 5 years). The data give us reasonable grounds to assume that the results of our study on the approaches to and tools for selecting topics for Master's theses can be scaled up for a larger population of respondents.

To determine the academics' approaches to identifying early career scientists' research directions, namely, formulating topics of Master's students' theses, and to identify links between groups of the respondents differing in their experience in supervising research (the above-mentioned groups with experience of up to 5 years, 5-10 years, and over 10 years) and their research areas (social sciences and the humanities, technical sciences, natural sciences), the following hypotheses were formulated:

H1: Research supervisors' approaches to formulating research topics do not depend on research areas, but are determined only by contextual characteristics.

H2: Research supervisors' approaches to formulating research topics do not depend on the respondents' quantified experience in supervising research.

H3. The choice of the publication database for maintaining relevance of early career scientists' research directions is influenced by the supervisors' experience in supervising early career scientists' research and by their research areas.

To confirm or refute the hypotheses, our respondents were asked to:

– check whether the topics of the Master's theses supervised by a particular academic match the research areas of their department, the areas of their own research or TOP research in their research area (Query group I, testing hypotheses H1 and H2);

– determine the publication database (out of scientometric bases, institutional repositories, etc.) for the analysis of the subject area and updating research directions (Query group II, testing hypothesis H3).

During the data analysis we used a set of methods and models which give the possibility to calculate all descriptive statistics. The choice of specific indicators was determined by the type of data, evaluation scale and limitations in the use of the methods. SPSS statistical software suite [25] was used to carry out calculations.

To accomplish objective 2 of this study, i.e. to develop the methods of applying bibliometric analysis to determine early career scientists' research directions, we used the method of systematic literature review (SRL) [26]. A simple analytical framework – Search, Appraisal, Synthesis and Analysis (SALSA) – was used to examine the review types to determine Master's research directions [27]. Since the purpose of SRL in this case is to identify the need for primary or secondary research (as opposed to conducting SRL as a stage of research), it is advisable to use rapid analysis [28] and systematic mapping [15].

Since the implementation of data synthesis requires applying to a statistician, especially if this is the first case of undertaking of meta-analysis, we propose in determining topics of research to use built-in bibliometric systems and VOSviewer, a tool for building and visualizing bibliometric networks. It should be noted that a comparison of the method of multidimensional scaling (MDS) and the method of visualization of similarities (VOS) to build bibliometric maps presented in [29], showed that maps created using VOS provide a more satisfactory representation of the base dataset than those built using MDS.

The use of bibliometric analysis and mapping involving these tools gives the possibility to analyze existing trends and patterns in scientists' publishing activity in specific research areas, which will help to keep early career scientists' research directions up-to-date, regardless of their research field and experience in using statistical methods and specialized tools for processing systematic literature review data.

To determine the effectiveness of the proposed methods, we used the case study method and a sample survey [24].

As a case of applying bibliometric analysis for formulating topics of Master's theses, we used research directions of students majoring in Education/Pedagogy (014 Secondary Education (Informatics)) and Information Technology (122 Computer Science) at the Department of Informatics and Methods of Its Teaching of Ternopil Volodymyr Hnatiuk National Pedagogical University: "3D modeling", "computer simulation", "gamification technologies", "artificial intelligence", "computer science training", "machine learning", "STEM education", "school K-12". Based on the methodology for systematic literature review applied to Engineering and Education [26], we chose Scopus and the Web of Science Core Collection as publication databases for our research. In order to select the most topical research, it was decided to introduce additional restrictions (filters), namely, to select articles (type of publications – Articles) published within the last five years (from 2016 to 2021) in the category Education Educational Research (WOS) or Social Sciences Area (Scopus) which are available for public viewing (Open Access). For an in-depth analysis, we used the fields "TITLE-ABS-KEY" (Scopus) and "Topic" (Web of Science). As a result of selecting metadata from these scientometric databases by different search queries, two data sets were formed: a W-set and a S-set.

To prepare the data for analysis by VOSviewer, the resulting W and S data sets were exported from the corresponding scientometric databases to .txt files (Web of Science) and .csv files (Scopus).

For VOSviewer, the major method of data analysis was the "co-occurrence" method, a method of clustering keywords by frequency of their use in one publication. To build scientometric maps, we used only those keywords that occur in each sample at least 5 times (standard VOSviewer threshold), deliberately excluding query terms, which are present in almost all documents and distort clustering. Comparison of thesauri and analysis of the created maps are the basis for identifying early career scientists' research directions, both current and prospective.

To determine the attitude of supervisors of Master's theses to the proposed methods of using bibliometric analysis to determine research directions, a sample added survey was conducted. The survey involved fewer persons – 67 of the 68 research supervisors. All survey participants have access to scientometric databases, though 82% of them use these databases only to search for necessary publications.

The respondents were asked to rate 5-point Likert scale from "Strongly disagree" to "Strongly agree": (i) "How much do you agree that the use of bibliometric analysis to determine research directions will contribute to the quality of preparation the Master's theses?"; (ii) "How much do you agree that the use of bibliometric analysis to determine research directions will contribute to the development of university science in the context of researchers' integration into the global research space?" Here we applied the same statistical methods and instruments as in the initial stage of our study. Results were estimated for the different respondents' groups. The significance of the obtained results was verified by the chi-square criterion at the significance level of p-value = 0.05.

3. RESULTS OF THE RESEARCH

3.1. Analysis of academics' approaches to identifying early career scientists' research directions

As a result of building frequency distributions of the respondents' scores in each question of the developed questionnaire (research objective 1), we determined Master's students'

research supervisors' approaches to formulating their students' research topics. It turned out that supervisors in the field of technical sciences significantly differ from their colleagues in natural sciences, social sciences and the humanities, in terms of correspondence of topics of their students' theses to the TOP research in the field (Fig. 1).
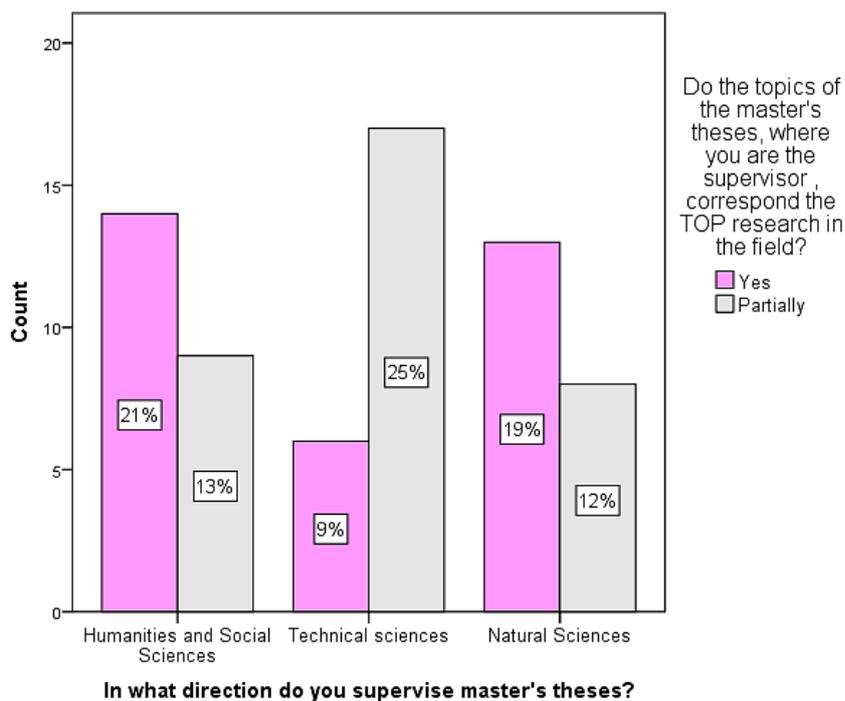

Fig. 1. Diagram of the respondents' answers distribution on the relevance of the topics of Master's theses to the TOP research topics depending on the direction of the supervisors' research

That is, when selecting and substantiating research topics of Master's students, the researchers in the field of technical sciences are primarily guided by the research areas of their academic department or institution, and their own research interests, rather than by state-of-the-art research in the field. This fact can be explained by the complexity of conducting experimental research in technical sciences, the need for expensive equipment and high qualification of researchers. No other significant differences were found. Regardless of the field in which the supervisors of Master's theses work, the topics of the Master's theses correspond to their scientific interests and research directions of the department. Hypothesis *H1* is partially confirmed with high level of probability.

We also looked at the respondents' answers about the relevance of topics of Master's theses from the perspective of their experience in supervising Master's students' research. As a result, hypothesis *H2* was rejected: research supervisors with up to 5 years of experience showed only a partial correspondence of the topics of the theses they supervise to research directions of their department, their own research interests and state-of-the-art research in the field. In Fig. 2 you can see the distribution of the respondents' answers on the relevance of the topics of Master's theses to the TOP-5 topics of research in the field depending on the experience. The same distributions we got on other questions, concerning the correspondence of the topics of Master's theses to department research and the supervisors' own research interests. Such answers can be explained by the supervisors' insufficient experience, which, on the other hand, potentially can give rise to original high quality research, as these academics are less limited by established research priorities.
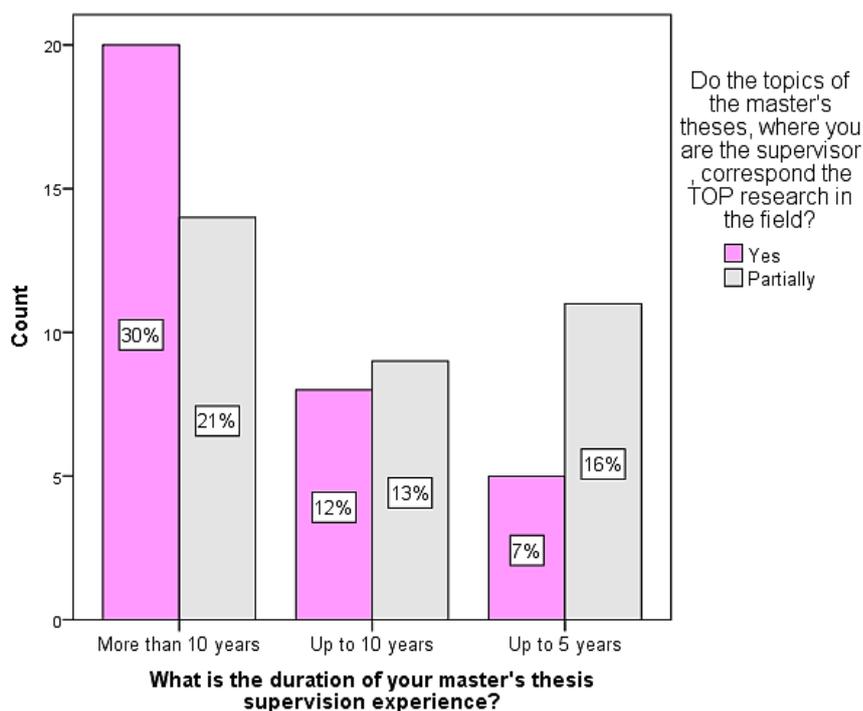
Fig. 2. Diagram of the respondents' answers distribution on the relevance of the topics of Master's theses to the TOP-5 research topics depending on the experience

Considering the respondents' answers about publication databases (testing hypothesis *H3*), we can conclude that regardless of the experience in supervising Master's students' research, institutional repositories are least used by research supervisors in identifying topical areas of research. The supervisors with experience of up to 5 years use institutional repositories in only 15% of cases. This group of respondents use Google Scholar resources more often than more experienced supervisors. Scopus and other scientometric databases are most often searched by supervisors with more than 10 years of experience (almost 27%), while supervisors with up to 10 years of experience use Scopus in only 21% of cases, and those with the experience of up to 5 years – in 24% of cases (Table 1).

Table 1

Frequency distribution of the respondents' answers on the use of research tools depending on their experience

Question			Research tools				Total
			Simple Google search	Google Scholar	Institutional repositories	Search in Scopus and other databases	
What is the duration of your experience in supervision of Master's theses?	More than 10 years	Count	21	22	14	21	78
		%	26.9%	28.2%	17.9%	26.9%	
	Up to 10 years	Count	11	10	9	8	38
		%	28.9%	26.3%	23.7%	21.1%	
	Up to 5 years	Count	6	15	5	8	34
		%	17.6%	44.1%	14.7%	23.5%	
Total		Count	38	47	28	37	150

Analyzing the respondents' answers about publication databases from the perspective of research areas, we saw that research supervisors in social sciences and the humanities, when searching for topics which can help identify prospective research directions of their Master's students, least of all resort to scientometric databases (only 13% of them indicated that they search Scopus and other scientometric databases). Most often, research supervisors in social sciences and the humanities search Google Scholar (32.6%), do simple Google search (28.3%), or use institutional repositories (26.1%). Supervisors of Master's theses in technical sciences also prefer Google Scholar (34.7%), though quite often do search in Scopus and other scientometric databases (28.6%). Scopus and other scientometric databases are most favoured by supervisors in natural sciences (more than 30%). These supervisors do search in Google and Google Scholar in 26% and 27% of cases, respectively (Table 2).

Table 2

Frequency distribution of the respondents' answers on the use of research tools depending on research areas

Question			Research tools				Total
			Simple Google search	Google Scholar	Institutional repositories	Search in Scopus and other databases	
In what direction do you supervise Master's theses?	Social sciences and the humanities	Count	13	15	12	6	46
		%	28.3%	32.6%	26.1%	13.0%	
	Technical sciences	Count	11	17	7	14	49
		%	22.4%	34.7%	14.3%	28.6%	
	Natural sciences	Count	14	15	9	17	55
		%	25.5%	27.3%	16.4%	30.9%	
Total		Count	38	47	28	37	150

These results showed that, when deciding on topics for Master's research, supervisors make the least use of institutional repositories, regardless of their experience in supervising Master's theses. Scopus and other scientometric databases are least used by supervisors whose experience does not exceed 10 years, as well as representatives of social sciences and the humanities.

Thus, according to the results of our survey, it can be concluded that research supervisors with little experience, as well as supervisors in social sciences and the humanities do not sufficiently use the channels and tools of modern digital scientific communications.

At the same time, the use of scientometric databases and bibliometric analysis tools to identify research directions in each given research area is essential for expanding research scope of universities' academic departments, thus facilitating their integration into global research community. Keeping the subject areas of early career scientists' research up-to-date can significantly contribute to this effect.

3.2. Identifying Master's students' research directions using bibliometric science mapping via VOSviewer

In the proposed case study, in accordance with the approved areas of research (in 2021-2022 academic year) of the Department of Informatics and Methods of Its Teaching of Ternopil Volodymyr Hnatiuk National Pedagogical University, we built terminological maps based on concepts occurring in titles, keywords and abstracts of scientific publications indexed in Web of Science (W data set) and Scopus (S data set).

For each data set W and S, using VOSviewer tools we:

– analyzed keywords, which gave us a possibility to estimate the intensity of a term occurring with other terms;

– compiled a special thesaurus to put together similar terms and eliminate mistakes in spelling keywords;

– built a science map by keywords (Fig. 3, 4), which highlights clusters (featured by different colors) combining key concepts (the size of a circle reflects the frequency of a specific term, its "total link strength") on the basis of their thematic relatedness. Within the clusters, the map reflects the closeness of links between related terms (the more related they are, the closer they appear on the map) and various options of term combinations both within the clusters and between them (the thickness of the lines reflects the so-called "link strength" between pairs of terms).

Fig. 3. "Total link strength" and "link strength" visualization in a concept map built for the W data set (minimum number of occurrences of keyword: 5)

Fig. 4. "Total link strength" and "link strength" visualization in a concept map built for the S data set (minimum number of occurrences of keyword: 5
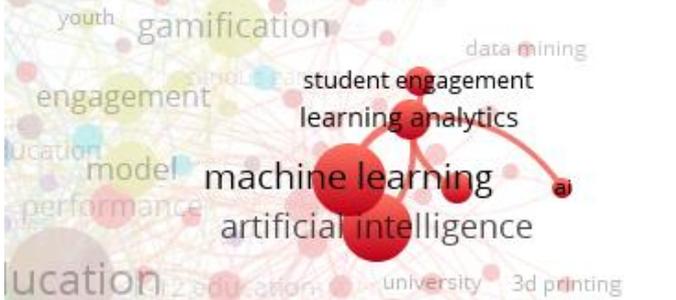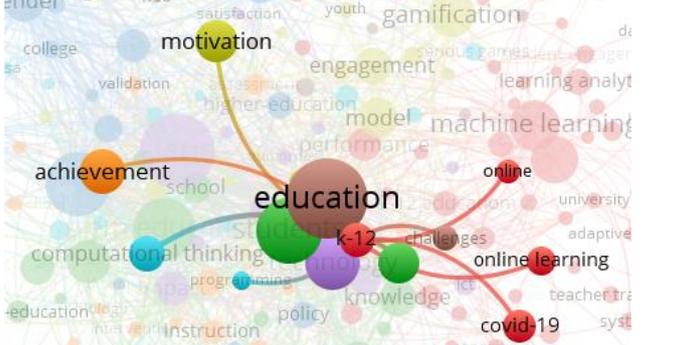
Having analyzed the map built for WoS publications (Fig. 3), we identified 8 main clusters reflecting major research directions:

– *Education policies* (blue), whose thesaurus includes the following terms (keywords of publications): higher education, gender, experience, identity, choice, policy, career, opportunities, K-12;

– *Innovative technologies* (red), including machine learning, online learning, adaptive learning, learning analytics, artificial intelligence, performance;

– *Science and technology* (purple), incorporating attitudes, perceptions, impact, conceptions, ICT, integration, framework, teacher, professional development;

– *Competences* (orange), defined and shaped, in particular, through assessment, skills, instruction, ability, modes, validation, self-efficacy, comprehension;

– *Design of educational systems* (green), including knowledge, design, teacher, implementation, inquiry, science education, curriculum;

– *Learning analytics* (brown), using and taking into account experience, behavior, challenges, survey, meta-analysis, teaching methods;

– *Gamification* (yellow), featuring game, technology, engagement, motivation, modes.

Based on the analysis of links between groups of terms, it is possible to formulate the topics of Master's theses (Table 3).

Table 3

Examples of topics of Master's theses, based on visualization of terminological links in the WoS data set

№	Fragment of the science map (Fig. 3)	Topics of Master's theses
1		Use of learning analytics data to study the degree of students' involvement in the use of machine learning and artificial intelligence in the process of formation of professional competencies
2		Research of tools to support students' positive motivation for study under COVID-19
3		Impact of gamification on increasing students' motivation for and engagement in mastering new technologies

Analysis of visualization of maps built on one query but from different scientometric databases (Fig. 3, Fig. 4) gives grounds for the assumption that different fields of knowledge show certain preferences in choosing a scientometric database to present research outcomes.
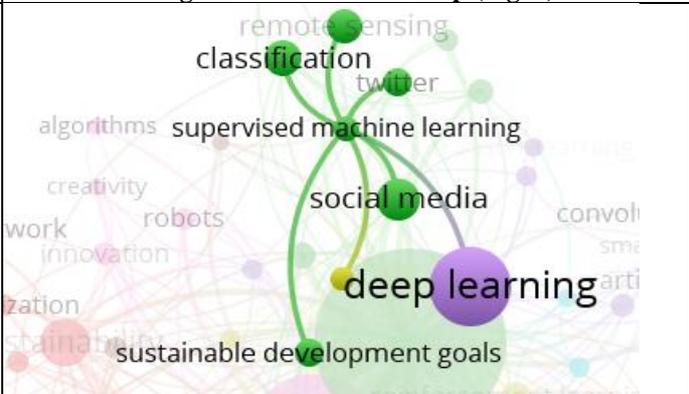
The WoS tends to present more research in the field of social sciences and the humanities, including educational sciences, whereas research in the field of technical sciences is better represented in Scopus (Fig. 4). In particular, based on the analysis of publishing activity in Scopus, in keeping with the research priorities of the department participating in the study, 10 clusters were identified:

– *Machine learning* (green), comprising such terms as supervised machine learning, data mining, sustainable development goals, crowdsourcing, social media;

– *Artificial intelligence* (pink), comprising the concepts of innovation, algorithms, creativity, robots;

– *Deep Learning* (purple), including transfer learning, convolutional neural network, artificial neural network;

– *Adaptive learning* (dark blue), with online learning, pandemic, survey, K-12 education, teacher;

– *Sustainability* (red), including virtual reality, gamification, higher education, industry 4.0, digital technology, assessment, sustainable development, bibliometric analysis;

– *Simulation* (light blue), comprising ensemble learning, e-learning, modeling, decision making, computer simulation;

– *Big data* (yellow) with data analysis, blockchain, Internet of Things, neural networks;

– *Education* (brown), associated with learning, teaching, technology, algorithm, data science;

– *Explainability* (orange), including trust, explainable artificial intelligence, transparency, chat-bot;

– *Decision-making* (nude), including neural network, decision tree, risk assessment.

The bibliometric map built on the basis of Scopus data can be used for formulating topics of Master's theses of the students majoring in Computer Science, trained by the Department of Informatics and Methods of Its Teaching at Ternopil Volodymyr Hnatiuk National Pedagogical University (Table 4).

Table 4

Examples of topics of Master's theses, based on visualization of terminological links in SCOPUS data set

№	Fragment of the science map (Fig. 4)	Topics of Master's theses
1		Development of a simulator for goal setting by machine learning tools

| 2 | | Use of virtual reality and gamification technologies in machine learning |
| 3 | | Development of a chat-bot to support training in artificial intelligence technologies (case study of machine learning under COVID-19) |

It should be noted that the proposed methods of using bibliometric analysis can help Master's in systematic analysis of literature both at the stage of substantiation of their research topic and later, while conducting the research [30].

On the other hand, the use of bibliometric systems and systematic mapping in determining the topics of Master's theses will contribute to students' deeper involvement in digital scientific communication and, consequently, raise both the quality of their personal research and overall research level at their university, which is important in the context of Ukraine's integration into global research space.

This has been confirmed by the results of a survey of research supervisors of Master's theses of two universities (67 people), which was conducted after the presentation of the proposed methods of using bibliometric analysis to determine early career scientists' research directions. The majority of the respondents fully agreed that the methods would contribute to both the quality of Master's research (Fig. 5) and the development of university science (Fig. 6): 61% and 55% respectively, although almost a third of the respondents were undecided.
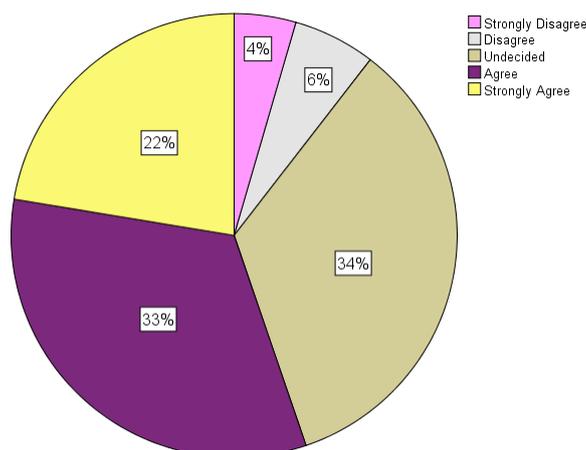

Fig.5 The distribution of answers on a 5-point Likert scale from "Strongly disagree" to "Strongly agree" for the question: "Do you agree that the using of bibliometric analysis in determining the directions of research will contribute to the quality of preparation the Master's research?"

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Fig.6 The distribution of answers on a 5-point Likert scale from "Strongly disagree" to "Strongly agree" for the question: "Do you agree that the use of bibliometric analysis in determining research areas will contribute to the development of university science in the context of the integration of researchers into the global scientific space?"

Such answers can be related to both the status of the respondents and the areas of their research. Most young academics believe that bibliometric analysis will contribute to both the quality of Master's training and the development of university science (81% of the respondents agreed and strongly agreed with this statement), while among the older academics the numbers are much lower (no more than 40%) (Table 5). The results are significant at the level of $p < 0.05\%$ (the verification was performed according to the chi-square criterion).

Table 5

The choice of teachers' answers depending on the status of the use of bibliometric analysis in determining areas of research

What is the duration of your Master's thesis supervision experience?	Do you agree that the using of bibliometric analysis in determining the directions of research will contribute to the quality of preparation the master's research?									
	Strongly Disagree		Disagree		Undecided		Agree		Strongly Agree	
	Count	%	Count	%	Count	%	Count	%	Count	%
More than 10 years	2	5,9%	4	11,8%	13	38,2%	12	35,3%	3	8,8%
Up to 10 years	0	0,0%	0	0,0%	4	23,5%	7	41,2%	6	35,3%
Up to 5 years	0	0,0%	0	0,0%	3	18,8%	5	31,3%	8	50,0%
What is the duration of your Master's thesis supervision experience?	Do you agree that the use of bibliometric analysis in determining research areas will contribute to the development of university science in the context of the integration of researchers into the global scientific space?									
	Strongly Disagree		Disagree		Undecided		Agree		Strongly Agree	
	Count	%	Count	%	Count	%	Count	%	Count	%
More than 10 years	3	8,8%	3	8,8%	16	47,1%	10	29,4%	2	5,9%
Up to 10 years	0	0,0%	1	5,9%	4	23,5%	6	35,3%	6	35,3%
Up to 5 years	0	0,0%	0	0,0%	3	18,8%	6	37,5%	7	43,8%

We received similar results for Master's supervisors on the directions of their research studies. Academics working in the fields of the humanities, social sciences and natural sciences are more skeptical about the use of the proposed methods, although most of them agree that it will contribute to the quality of Master's training and the development of university science. The results are significant at the level of $p < 0.05\%$ (the verification was performed according to the chi-square criterion).

In addition, according to the results of additional in-depth interviews conducted with the survey participants, the proposed methods will give an opportunity to expand the range of the topics of Master's theses and keep them up-to-date, strengthen the students' motivation to conduct research and adhere to the research schedule by optimizing the process of formulating the research problem and literature analysis, intensify publishing activities both of students and academics. The latter will contribute to deeper integration of researchers into the global research space, which is reflected, in particular, in the ratings of both individual researchers and higher education institutions.

4. CONCLUSIONS

The research potential of higher education institutions in general, and the quality of Master's training and integration of early career researchers into the global research space in particular, to a large extent depend on the choice of research directions both at the level of structural academic units and at the level of individual research.

Keeping Master's research directions up-to-date and in line with state-of-the-art research in their field, engaging them in real research projects are the primary responsibility of their research supervisors. The conducted survey of 68 academics from the National University of Life and Environmental Sciences of Ukraine and Ternopil Volodymyr Hnatiuk National Pedagogical University on their approaches to and tools used for selecting topics of Master's theses, gave us the grounds to assume that Master's thesis supervisors with little experience (up to 5 years), as well as academics in the field of social sciences and the humanities lag behind in the use of modern means of scholarly communication.

We proposed the methods of applying bibliometric analysis for selecting and updating directions of Master's research, that differs from existing ones that take into account both the research scientific areas and work experience of Master's supervisors.

To confirm the effectiveness of the methods we proposed to analyze a case study of the Department of Informatics and Methods of its Teaching at Ternopil Volodymyr Hnatiuk National Pedagogical University. The analysis covered scientific publications from two scientometric databases, Scopus and Web of Science Core Collection, obtained from search queries matching the Department's research directions (keywords: 3D modeling, computer simulation, gamification technologies, artificial intelligence, computer science training, machine learning, STEM education, school K-12) for the years 2016-2021, in the categories Education Educational Research (WoS) and Social Sciences Area (Scopus), which are available for public viewing (Open Access).

The analysis of visualizations of terminological maps confirmed the somewhat different directions of research presented in these scientometric databases – publications from the Scopus data set have a more technical orientation, whereas those from the Web of Science are more representative of research in social sciences and the humanities. As the Department trains Master's students in two different fields (Education/Pedagogy and Information Technology), based on the analysis of links in thesauri from the Web of Science and Scopus data sets, we identified research directions and provided examples of topics for Master's theses in Educational Technology and Information Technology, respectively.

The results of a sample survey and in-depth interviews of 67 research supervisors of Master's students, conducted after a presentation of the proposed methods of using bibliometric analysis to determine research directions of early career researchers, confirmed the feasibility of the practical application of this methods, regardless of research area and experience in using statistical methods and specialized tools for processing systematic literature review data.

We see the prospects of further research in conducting a broader pedagogical experiment involving the use of educational analytics tools to identify specific features of determining research directions of early career researchers in various fields of science, relying on a wide range of bibliographic analysis tools. We also plan to develop guidelines on the use of the proposed bibliometric analysis tools for systematic analysis of literature by early career researchers both at the stage of substantiation of their research topic and while conducting their research.

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ВИКОРИСТАННЯ БІБЛІОМЕТРИЧНОГО АНАЛІЗУ ДЛЯ ВИЗНАЧЕННЯ НАПРЯМІВ ДОСЛІДЖЕНЬ МОЛОДИХ НАУКОВЦІВ

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Анотація. У статті наведено огляд публікацій щодо використання бібліометричного аналізу в різних наукових дослідженнях. Виявлено, що використання інструменту наукового картування як одного із засобів такого аналізу на етапі визначення напрямів досліджень молодих науковців не вивчено. За результатами проведення вибіркового статистичного опитування 68 керівників досліджень магістрів із Національного університету біоресурсів і природокористування (НУБіП) України та Тернопільського національного педагогічного університету імені Володимира Гнатюка (Україна) виявлено, що недосвідчені керівники, а також керівники в галузі суспільно-гуманітарних наук недостатньою мірою використовують канали та інструментарій сучасних цифрових наукових комунікацій. Висловлено припущення, що використання вбудованих інструментів бібліометричних систем для здійснення систематичного аналізу при визначенні напрямів досліджень магістрів сприятиме якості підготовки магістерських дисертацій, а відтак і розвитку університетської науки в контексті інтеграції до єдиного наукового простору. Запропоновано кейс реалізації наукового картування за результатами запитів щодо пошуку наукових публікацій у наукометричних базах даних Scopus та Web of Science на прикладі тематики досліджень кафедри інформатики та методики її навчання Тернопільського національного педагогічного університету імені Володимира Гнатюка. Описано підходи щодо використання VOSviewer для побудови термінологічних карт на основі понять, що зустрічаються в назвах, ключових словах та анотаціях відповідних наборів публікацій. Оскільки на кафедрі забезпечується підготовка магістрів як у галузі знань 01 Освіта/Педагогіка (014 Середня освіта (Інформатика)), так і 12 Інформаційні технології (122 Комп'ютерні науки), на основі аналізу зв'язків у тезаурусах з наборів даних Web of Science та Scopus визначено напрями досліджень та наведено приклади формулювання тем для досліджень магістрів з освітніх технологій та інформаційних технологій відповідно. Підтверджено різну спрямованість досліджень, представлених у різних наукометричних базах даних. За результатами опитування та глибинних інтерв'ю керівників магістерських робіт визначено доцільність розширення педагогічного експерименту щодо розробки методики здійснення системного огляду літератури на різних етапах проведення досліджень магістрів з використанням широкого спектру засобів бібліографічного аналізу. Результати, подані в цій статті, можуть бути корисними як для молодих дослідників, так і для їх керівників.

Ключові слова: бібліометричний аналіз; бібліометричне наукове картування; молоді дослідники; магістерська робота; огляд, вища освіта.