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GREEN COMPETENCE AND HIGHER EDUCATION – A BIBLIOGRAPHIC ANALYSIS

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ABSTRACT: The transition from a brown to a green economy creates a demand for workers equipped with green competencies. Understanding what these competencies entail and how to develop them is crucial. Higher education institutions should play a pivotal role in educating society, incorporating green practices into university management, and disseminating research findings. This article presents the results of a bibliometric analysis of academic research on green competencies within the context of higher education. Specifically, the study seeks to examine the presence and frequency of publications on this subject, identify the dominant authors, and explore the primary areas of interest among researchers. This objective was achieved through a review of domestic and international literature and a bibliometric analysis conducted using VOSviewer software. The research indicates that this topic is not yet widely represented in the academic literature. However, there has been a noticeable increase in the number of publications in recent years, suggesting growing interest in this area. Furthermore, there is a clear shift from a focus on environmental education towards environmental management and sustainable development issues within higher education institutions.

KEYWORDS: green skills, green education

Introduction

In December 2019, the President of the European Commission (EC), Ursula von der Leyen, introduced a reform proposal for the European Union's climate policy, the European Green Deal (EGD). The EGD aims to address climate and environmental challenges while transforming the EU into a fair and prosperous society operating within a modern, resource-efficient, and competitive economy. By 2050, this economy is expected to achieve net-zero greenhouse gas emissions, with economic growth decoupled from the use of natural resources (European Commission, 2019).

Implementing the EGD aims to transition from a brown economy (primarily based on exploiting fossil fuels) to a green economy reliant on renewable energy sources. This shift is expected to trigger a "green recovery," fostering economic development by focusing on green jobs. It is important to emphasise that, according to experts, the green transformation should impact both the overall number of jobs in the economy and the structure of these jobs in terms of sectors, professions, and qualifications (Szczepanik, 2024). These changes will be reflected in the decline in demand for workers in "declining" industries – those whose scale of activity will shrink in the context of the green transformation – while demand will increase in industries with significant potential for green growth (Konfederacja Lewiatan, 2022). At the same time, the green revolution will lead, regardless of the sector, to transforming many existing jobs into greener roles, which will, in turn, require employees to possess specific green competencies.

The demand for workers with green competencies necessitates a broad understanding by various stakeholders (including employers, educational institutions, and the workers themselves) of what green competencies are and how they can be developed and enhanced. It is essential to implement actions at every level of education that will equip individuals with the necessary knowledge and skills for green jobs. Significant are the efforts undertaken at the higher education level, as this sector provides the managerial workforce for the economy. Only environmentally conscious leadership will make responsible environmental decisions and foster pro-ecological attitudes among their employees.

According to the authors, it is essential to analyse whether and to what extent research is being conducted on developing green competencies within higher education. Therefore, this study aimed to present the results of a bibliometric analysis of scientific research on developing green competencies, focusing on activities at the higher education level. The authors intended to identify the research areas related to this issue and to track the dynamics of changes in interest in the subject. The VOSviewer software and data analysis tools available in the SCOPUS database were used for this analysis.

Green competence and its development

There are many definitions of green competence (also referred to as competence for green transformation, environmental competence, or ecological competence (Kozar, 2019). However, these definitions are similar, with the authors emphasising the various elements of these competencies and how they are used. For example, in 1980, F. Steele stated that "green competence is people's ability to deal with immediate surroundings in an effective and stimulating manner" (Cabral & Dhar, 2021). In turn, P. Vega-Marcote and colleagues describe green competencies as sets of knowledge, skills and personal attributes that allow effective task performance and problem-solving about real sustainability challenges and opportunities (Vega-Marcote et al., 2015). According to Dlimbetova et al. (2016) green competencies include personal qualities, skills, knowledge and abilities to reduce energy consumption, protect ecosystems and biodiversity, and minimise emissions and waste.

In consequence, it can be concluded that green competence consists of (Szczepanik, 2024):

- Green awareness – understood as an awareness of the impact of human activities on the environment and climate (causes and effects);
- Green knowledge – refers to general knowledge about the environment and nature;
- Green attitudes – understood as individuals' perception of the value of environmental and climate protection;
- Green behaviour – supporting environmental sustainability and reducing negative human impact on the climate;

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- Green capabilities – necessary for self-development and increasing productivity in the green economy;
- Green skills – skills of a professional and general nature that are essential for a green transformation.

In doing so, it should be noted that green competencies can be understood as specific qualifications and skills (often technical) for green jobs, above all in industries where the green transformation will be most dynamic (Konfederacja Lewiatan, 2022). Identifying such skills is relatively simple due to their association precisely with specific industries or occupations within those industries. Ziółkowska (2024) presented an exemplary sectoral classification of green competencies. For example, green competences for the sustainable agriculture sector include: understanding of sustainable farming techniques such as ecological farming, conservation agriculture and agroforestry, while, for example, for the ecological transport sector, competences such as: understanding of sustainable transport systems, such as public transport, cycling and electric vehicles.

Secondly, green competencies can also be horizontal – they are found in all industries or professions, even those not directly related to the green transformation; however, this transformation somehow forces them to be shaped (Konfederacja Lewiatan, 2022). An example of such a set of competencies can be found in the 2022 European Competence Framework for Sustainable Development (GreenComp). It identifies four groups of competencies related to sustainability that learners of all ages should acquire (European Commission, 2022):

1, Actualising sustainability values:
- reflecting on the value of sustainability,
- promoting integrity,
- promoting nature,

2. Accepting the complexity of sustainability:
- systems thinking,
- critical thinking,
- problem formulation,

3. Acting for sustainability:
- political agility,
- collective action,
- individual initiative,

4. Visualising a sustainable future:
- ability to think about the future,
- adaptability,
- exploratory thinking.

As Abdelkareem et al. (2024) point out, it is highly desirable for society members to have green competencies, as individuals with developed green skills often show a deeper understanding of and commitment to environmental protection. This increased awareness contributes to a desire to reduce one's negative impact on the environment, adopt environmentally friendly behaviour, reduce waste and better manage natural resources.

Therefore, all activities contributing to developing green competencies must be undertaken. A state policy focused on sustainable development must also be established, as well as business initiatives (employee training) or actions at all levels of education to shape and enhance green competencies.

Murga-Menoyo (2014) suggests that countries, as well as the institutions and organisations within them at the national and international levels, should take action in three main areas:
- reorienting education to sustainability, taking into account changes in the natural, social and economic environment and human development (including its spiritual aspects), and integrating this education into all fields of study,
- raising public awareness to reinforce sustainable attitudes, values and actions, and prioritising accountability and local control over actions in this regard,
- promoting training that prioritises acquiring knowledge conducive to employment and participation in environmental and developmental issues activities.

In companies, on the other hand, managers must invest in developing competencies through training, creating a culture that promotes sustainability, and synchronising efforts with an overall

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sustainable growth policy (Abdelkareem et al., 2024). In turn, education systems should support the acquisition of green competencies by equipping young people with the necessary skills to function in the green economy and society. In addition, they should offer opportunities for adults to adapt to changes resulting from the green transition (Cedefop, 2022).

As stated in the Skills for a Green Economy report, secondary and tertiary education have a particularly important role in "embedding skills for a green economy in their courses and ensuring teachers, trainers, (…) have the necessary capabilities to undertake this widening role" (HM Government, 2011).

Aithal and Rao (2016) point out that green education is essential in higher education, as it plays a crucial role in creating and developing human capital. There is a growing demand for green jobs, so many managers and employees who are oriented towards environmental aspects are needed. To meet the requirements of 'greenness', higher education must focus on developing knowledge, skills and attitudes related to environmental protection. According to the indicated authors, in order to educate students in a green way, universities should (Aithal & Rao, 2016):

- Transmit knowledge innovatively and interestingly (learning orientation rather than teaching orientation);
- Incorporate subjects such as agriculture, organic farming, green transport, green tourism, and climate and atmosphere into the curriculum, following the principle of "learning by doing" to ensure effective learning outcomes;
- Increase students' knowledge of the use of green technologies;
- Increase public awareness of sustainability and the consequences that may result from inaction;
- Focus the curriculum on green education by incorporating current knowledge and skills needed by the industry;
- Implement the concept of sustainability in all processes in industry and society.

Universities can become environmental management models by implementing sustainable practices on their campuses. The concept of 'green campuses' is becoming increasingly popular worldwide. It aims to raise the level of environmental awareness among both students and staff. It involves introducing environmentally friendly solutions, such as bicycle parking, waste segregation, zero-waste programmes, paper-saving programmes, and energy and water-saving technologies. The green campus concept also includes principles for using certified and recycled building materials and engineering solutions that reduce energy consumption and campus maintenance costs, including optimising management systems and infrastructure monitoring (Abakumov & Berensten, 2023).

As noted by Pavlova (2017), incorporating environmental topics into the curricula of all higher education disciplines is an effective way to build widespread ecological awareness. However, while "greening" education is already underway in many European countries, it often remains fragmented and has a limited impact on the greening of industry and the broader economy (Pavlova, 2017). Therefore, it is reasonable to analyse the measures already undertaken in greening higher education and benefit from the good practices introduced at different universities.

Bibliographic analysis

In order to assess the scale of interest in developing green competencies in higher education, the authors decided to conduct a bibliometric analysis. They searched for academic publications indexed in the Scopus database that included the following terms in the title, abstract, or keywords: green competence, green skills, ecological competence, environmental competence, occurring together with the terms: university, universities, colleges, higher education. A dataset of 224 articles from various research fields was obtained using this search key. The raw data for the study were obtained from the Scopus database on 3 September 2024.

The most significant portion of the articles came from the fields of social sciences, business, management and accounting, and environmental science. Additionally, more than 5% of the articles were found in the engineering, agricultural and biological sciences, energy, and arts and humanities sections.

For the selected dataset of 224 articles, keyword co-occurrence was analysed using VOSviewer software. Exporting the 224 files from the Scopus database to VOSviewer resulted in the identifica-

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tion of 1,515 co-occurring terms. In order to ensure the readability of the created word association map, only terms that appeared at least five times in the analysed set of papers were included. This reduced the number of keywords to 41. Next, the term "article", not substantively related to the analysed research area, was excluded from the set, reducing the number of analysed words to 40.

Considering the indicated 40 words, it was possible to generate a network of associations and isolate five clusters, which are, at the same time, research sub-areas concerning the issue of green competencies and universities. The names of these clusters proposed by the authors refer to most of the terms identified within each cluster in the co-occurrence analysis of the indicated keywords. A map of the links between the keywords is shown in Figure 1.

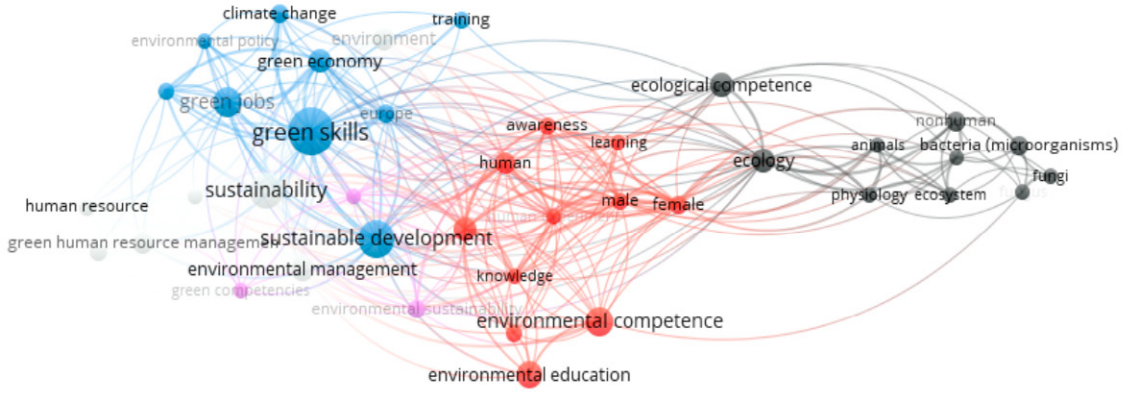

Figure 1. Keyword network

Source: authors' work based on SCOPUS data and VOSviewer software.

The identification of five clusters within publications combining the topics of green competence and higher education indicates that green competence is not a one-dimensional concept but can be considered from multiple perspectives.

Indeed, universities can be seen as key centres for shaping pro-environmental attitudes and developing environmental competencies. Cluster 1 (red), which the authors entitled '**Education and Environmental Awareness',** focuses on increasing public awareness of the environment, environmental education, environmental competencies and various aspects related to human development and experience.

Cluster 2 (black), '**Ecology and Nature'**, focuses on elements of ecology such as animals, microorganisms (bacteria, fungi), ecosystems and ecological competence and research related to physiology and environmental functioning. Ecological and natural components have long been firmly integrated into university education programmes worldwide, and understanding nature's interconnectedness is key to the development of green competencies, so it was obvious to the authors to identify such a thematic cluster as linking university topics and green competencies.

Cluster 3 (blue) has been named '**Sustainability Policy and Economics'**.

Studies within this cluster are concerned with climate change, environmental policy, environmental economics, the green economy and employment, sustainable development, and training. Identifying such a cluster may indicate the need to educate students in green skills and sustainability policy to support the green economy and prepare them for green jobs.

Cluster 4 (white) – '**Sustainability management'** focuses on environmental management, eco-efficiency, human resource management in the context of sustainable development and general aspects of sustainability. Publications within this cluster show that environmental aspects can also be examined from the business side, analysing their efficiency and effectiveness. This approach to environmental management can be represented by all actors, including universities themselves, who can become role models by implementing sustainable practices and resource management on their campuses.

The smallest cluster, 5 (pink) – '**Competences for environmental sustainability'**, focuses on environmental protection, ecological sustainability and the development of competencies related to the green economy. Publications from this cluster point to the important role of universities in developing environmental and sustainability competencies.

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The authors then traced the development of interest in the analysed topic by examining the years in which publications appeared within each identified cluster. The timeline of these publications is presented in Figure 2.

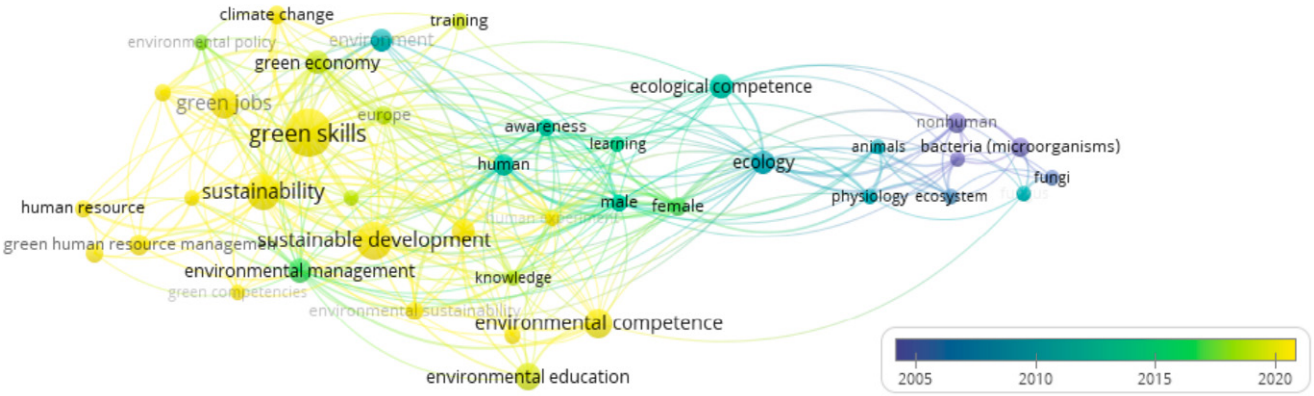

Figure 2. Keyword network including year of publication

Source: authors' work based on SCOPUS data and VOSviewer software.

Figure 2 shows that the topics of higher education and green competencies were first connected within Cluster 2, titled "Ecology and Nature", as most publications in this area emerged around 2005. On the other hand, between 2010 and 2015, researchers became increasingly interested in Cluster 1, which the authors have titled "Education and Environmental Awareness". In contrast, the topics of Clusters 3 and 4 represent relatively new research areas, as publications on sustainable development policy and economics, as well as environmental management and sustainability, in the context of higher education and green competencies, only began to emerge around 2020. Cluster 5 topics, on the other hand, are a relatively new and rapidly developing area of research in the context of green competencies and universities. Although this topic is gradually gaining significance, scientific materials in this area remain fewer than in other, more established fields.

Thus, it can be concluded that publications linking higher education and green competence issues are evolving from those focused more on natural aspects, such as ecology and nature (cluster 2) and environmental education itself (cluster 1), towards analysing issues related to policy, the economics of sustainability and environmental management and sustainability (cluster 3, cluster 4, cluster 5). This trend shows a progressive move of researchers' interests from purely natural and ecological issues to a more holistic approach that also considers the educational, political, economic and managerial aspects of sustainability in the context of higher education institutions.

Table 1. Number of publications in the Scopus database on green competencies and higher education institutions by year of publication

Years	Number of publications
1979-1982	2
1983-1988	3
1989-1994	3
1995-2000	10
2001-2006	12
2007-2012	13
2013-2018	43
2019-2024	138

Source: authors' work based on SCOPUS data [03-09-2024].

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The growing number of such publications in recent years was also highlighted when analysing the development of publications linking higher education and green competencies over time. Although the first articles in this field appeared as early as the 1980s, the highest publication activity in this area falls between 2019 and 2024.

Y. Kamin has the most significant publication output concerning the intersection of green competencies and higher education, with eight articles; S. Hamza has five articles, and G. Marin has four. Figure 3 summarises the nine authors with the highest number of articles in the analysed area (as of 3 September 2024).

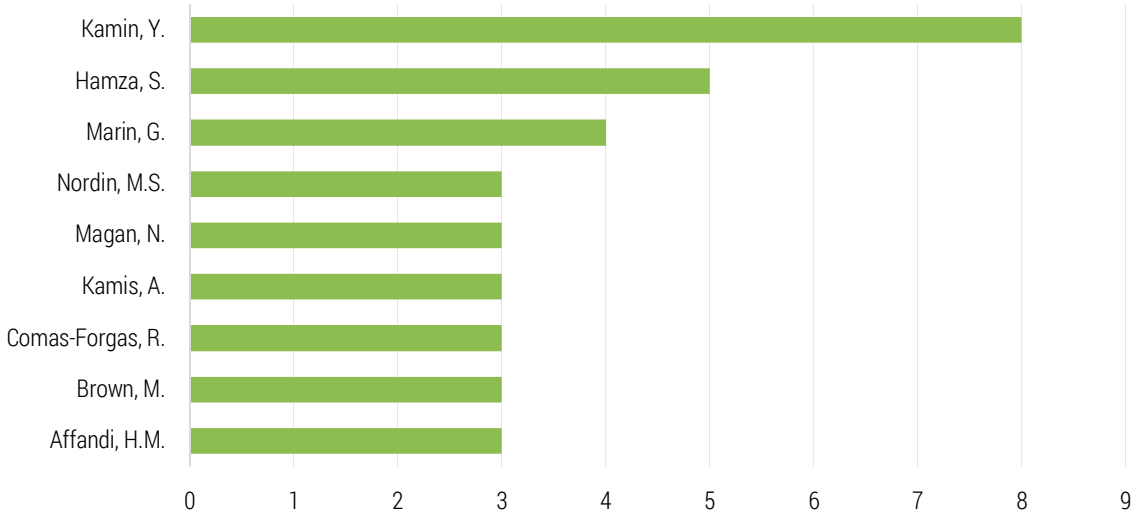

Figure 3. Authors with the highest number of publications on green competence and higher education institutions

Source: authors' work based on SCOPUS data.

Table 2 reviews the topics covered by the articles written by the indicated authors.

Table 2. Content of articles by authors with the highest number of publications linking the topics of green competencies and higher education institutions

Author(s)	Publication name (year of publication)	Citation count	Topics of the article
Hamza, S., & Kamin, Y.	„Integration factors of green skills into building construction trade programme in Nigeria" (2020)	2	S. Hamza and Y. Kamin co-authored articles focused on implementing green technology skills in education programmes related to construction and electronics, emphasising increasing engagement and environmental awareness among students.
	„Exploring essential generic green skills for green jobs in the field of electrical electronics" (2020)	2	
	„Exploratory factor analysis of green innovative skill elements in building construction programme for economic sustainability" (2019)	1	
	„Assimilating Green Skills in Building Construction Programme: Crucial to Realising Environmental Sustainability" (2019)	1	
	„A preliminary study of the awareness and applications of green skills: Students' perceptions" (2017)	0	

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Author(s)	Publication name (year of publication)	Citation count	Topics of the article
Kamin, Y.	„Generic green skills in teaching and learning: Meaning and implementation" (2019)	6	In addition to the topics of the co-authored articles written with S. Hamza, Y. Kamin focuses on the understanding and implementation of generic green skills in education and their relevance for achieving sustainable development and on the adaptation of technical and vocational teacher education for the acquisition of green skills.
	„Paving sustainable development through generic green skills based on desk research" (2019)	0	
	„Refocusing technical vocational teacher education towards green skill acquisition for sustainable development in Nigeria" (2019)	0	
Marin, G.	„Citizens' attitudes towards climate mitigation policies: The role of occupational exposure in EU countries" (2023)	0	The author focuses on the impact of climate and economic policies on the labour market and the development of sustainability skills in a changing environment.
	„The Employment Impact of a Green Fiscal Push: Evidence from the American Recovery and Reinvestment Act" (2021)	4	
	„Green Stimulus in a Post-pandemic Recovery: the Role of Skills for a Resilient Recovery" (2020)	39	
	„Environmental regulation and green skills: An empirical exploration" (2018)	76	

Source: authors' work based on SCOPUS data.

The information presented in Table 1 shows that the authors identified have been publishing in the subject area for a short time, as their publication activity is between 2017 and 2023. At the same time, their articles are not cited very often. The most cited article from those mentioned above was by G. Marin, *"Environmental regulation and green skills: An empirical exploration*". In the case of the analysed set of 224 articles, the most frequently cited papers have over 300 citations. The most cited article in this set is the article by F. Ganda, *"The impact of innovation and technology investments on carbon emissions in selected organisation for economic Co-operation and development countries*", dating from 2019 (classified in engineering sciences, management sciences and environmental sciences).

In conclusion, it is worth highlighting that publications addressing the issue of green competencies in higher education originated from 66 countries, with the highest contributions coming from the United Kingdom, Spain, the United States, and Malaysia (31, 24, 23, and 22 articles, respectively). Additionally, ten articles from Poland were recorded.

Conclusions

Global changes in the economy and the labour market drive educational institutions to reformulate their educational programmes to include knowledge and skills related to sustainability. These activities within higher education institutions are of particular importance. Among other things, HEIs should enrich existing programmes with environmental aspects, create new courses related to sustainability, and organise specialised courses, workshops and projects that directly involve students and the academic community in pro-environmental activities. Furthermore, universities can introduce the idea of green campuses, thus demonstrating how sustainability-related theories can be implemented.

The bibliographic analysis[1] conducted and the keyword mapping with the VOSviewer tool showed that researchers do not yet address topics linking green competencies and higher education institu-

[1] Unfortunately, a weakness of the bibliographic analysis must be pointed out. It is limited to quantitative data and ignores the context and quality of the work, which can result in simplifications. Therefore, according to the authors, it is recommended to combine it with qualitative analyses in research.

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tions very often. However, the increase in the number of publications in recent years indicates a growing interest in this issue.

According to the authors, the scientific output to date in this area can be divided into five research areas. An analysis of the years in which the publications included in each area appeared makes it possible to see a change in the approach to linking issues of green competence with those of higher education. At first, the focus was on environmental education. Attention began to turn to environmental and ecological awareness. In recent years, there has been a growing interest among authors in education in environmental management and sustainable development, as well as in the politics and economics of sustainable development.

It should be believed that the popularisation of the trend from a brown to a green economy worldwide, and in Europe also the implementation of the guidelines of the European Green Deal, will result in a growing interest in green competencies and ways of shaping them, including within higher education. This, in turn, will undoubtedly result in a further increase in publications in this area.

The contribution of the authors

Conceptualisation, U.G.K. and J.A.; literature review, U.G.K. and J.A.; research methods, U.G.K. and J.A.; formal analysis, U.G.K. and J.A.; writing, U.G.K. and J.A.; conclusions and discussion, U.G.K. and J.A.

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ZIELONE KOMPETENCJE A SZKOLNICTWO WYŻSZE – ANALIZA BIBLIOGRAFICZNA

STRESZCZENIE: Przejście od gospodarki brązowej do zielonej rodzi popyt na pracowników o zielonych kompetencjach. Zrozumienie, czym są i jak kształcić te umiejętności, jest kluczowe, a szkolnictwo wyższe powinno edukować społeczeństwo, wprowadzać zielone praktyki do zarządzania uczelnią oraz upowszechniać wyniki badań w tym zakresie. Celem artykułu stało się zaprezentowanie wyników analizy bibliometrycznej badań naukowych dotyczących problematyki zielonych kompetencji w kontekście szkolnictwa wyższego. W szczególności zamierzano zbadać, obecność i częstość publikacji, a także autorów dominujących w tej tematyce oraz główne obszary zainteresowań badaczy. Powyższy cel został zrealizowany dzięki analizie dostępnej literatury krajowej i zagranicznej oraz przeprowadzeniu analizy bibliometrycznej przy wykorzystaniu oprogramowania VOSviewer. Przeprowadzone badania wykazały, że tematyka ta nie jest jeszcze szeroko obecna w literaturze naukowej. Obserwuje się jednak wzrost liczby publikacji w ostatnich latach, co sugeruje rosnące zainteresowanie tą problematyką. Jednocześnie widoczne jest wyraźne przechodzenie od tematyki dotyczącej samej edukacji środowiskowej do problematyki zarządzania środowiskowego i zrównoważonego rozwoju w kontekście uczelni wyższych.

SŁOWA KLUCZOWE: zielone umiejętności, zielona edukacja