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A scientometric analysis of global scientific literature on learning resources in higher education

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Research article

A scientometric analysis of global scientific literature on learning resources in higher education

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A B S T R A C T

There is a significant increase in the literature on learning resources in Higher Education (HE) but very limited evidence of studies that have taken a global overview of the context, range, and emerging trends from the previous research. This study aims to conduct a Scientometric analysis of research articles to accommodate a global overview and research trends under the theme of learning resources in HE. 4489 scientific articles were obtained as the dataset from the Web Of Science database between 1970 and 2022. Network maps and critical data were obtained by conducting co-authorship analysis for authors, organisations and countries and co-occurrence analysis for keywords from the VOSviewer software. The study revealed that the USA had a significant research input, and Salamin, N. from the University of Lausanne was recognised as the most frequently published author. The University of Illinois, USA, has the highest contribution to research articles, and the most popular research hotspots and trends were e-learning, Education, Academic libraries, Learning resources, and Cloud computing. However, the most critical finding from the study is that there needs to be real collaboration within the research theme and suggests ways to improve collaborations to enhance learning resources in HE. This study may be the first to conduct a scientometric analysis of Learning Resources in Higher education. This study offers valuable insight to academics, academic institutions, researchers, policymakers and pedagogical statutory bodies to understand the current context of learning resources in HE and recognise further develop research, collaborations and policies by considering critical findings from the study.

1. Introduction

The availability of learning resources in Higher Education (HE) is essential in course management and student progression [1,2]. Studies reveal that learning resources directly influence how successful pedagogical implementation is regardless of learning and educational and cultural contexts [3,4]. Lack of resources and the infrastructure in facilitating learning resources, disintegration

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between contemporary research and learning resources available at HE curricula, and lack of awareness of the availability of resources are prominent issues identified within the literature [5–8]. Emphasis is given by HE Institutions (HEIs) on making learning resources available to students. The focus on synchronous learning throughout the COVID-19 pandemic changed the traditional practice of course management, thus, influencing the use of e-learning resources [9–11]. Although the implications of creating awareness of learning resources have been prominent in HE, studies identify a general lack of successful implementation.

Additionally, global studies identified a significant decline in student satisfaction concerning the availability of learning resources [12,13]. Nonetheless, the use of e-learning resources has been a significant attribute within the HE curricula in recent years and needs to be further emphasised in enhancing student support [14]. The National Student Survey (NSS) data in 2020 and 2021 highlights the dire need to improve learning resources in the HE context within the UK. NSS records that the satisfaction level has reduced the average minimum scoring criteria from 79% to 70% [15]. NSS has recorded a significant decrease in library resource availability, scoring 76% in 2020 and 70% in 2021. The availability of IT resources documented another reduction of 80% in 2020 and 71% in 2021. Similarly, the availability of course-specific resources recorded a decrease, where it obtained 81% in 2020 and 71% in 2021. Studies further identify using Ubiquitous learning tools in HE to improve accessibility and context-aware learning in developed countries [5,7]. However, considering the infrastructure availability, using such Ubiquitous learning tools in developing countries is yet to be researched and determined.

Considering the above, there is significant apprehension about the availability of learning resources in a global HE context. The literature reviewed (section 2.0) and the results obtained (section 4.0) reveal a significant need for research on HE learning resources. Although there are publications on other themes within HE pedagogical implementation, very limited guidance and framework are made available for using resources in HE [9,16]. Most literature tends to emphasise digital adaptations rather than effective implications of learning resources in HE curricula [7,16,17]. However, the main issue remains the limited identifiable literature surrounding the analysis of the global use of learning resources within HE. Although guidance, frameworks, successful implementation and student satisfaction remain key issues, the study recognises the need for advancing and enhancing the research within the theme of learning resources in HE.

Thus, the following study aims to carry out a scientometric analysis of the current research trends and the existing literature under the theme of "learning resources in HE". The aim of the study could be further broken into research objectives by identifying the most productive authors, organisations, and research-led countries and identifying research trends within the given timeline. The insights and the motivation behind such research objectives are to understand the prominent research authors, institutions and countries leading in research within the theme of Learning Resources in HE. Furthermore, the last objective predominantly focuses on understanding shifts of research focus within the given framework of time. This will be useful in interpreting current research trends and knowledge gaps that need to be addressed going forwards. These objectives will be further reflected and used as the underpinning structure for the results and discussion section of the study.

2. Current context of learning resources in higher education

A broad range of learning resources is used within the current pedagogical context. It is recognised that learning resources differ, and the term is used within different education levels, discipline contexts and focus areas [18–20]. There is limited guidance and underpinning on the use of such learning resources to enhance current learning and teaching in HE within the identifiable body of knowledge [21,22]. Learning resources have been defined as any resource, including tools, equipment, printed or digital materials with online, tangible or open-access, that support teaching and improve and enhance student learning[23]-UNESCO, 2016; [24]. Further guidance is provided by the [25] and the office for students (2020) in defining and identifying prominent themes within the learning resources. These themes are presented in the NSS, Section 6 – Learning resources [15]. NSS is a nationwide survey carried out in the UK to understand the current context of learning and teaching in HE by assessing different pedagogical attributes within the HE curriculum. The NSS data is considered a centralised source for enhancing pedagogical practices within HE academic institutes (HEIs). Thus, the theoretical underpinning of the study was based on the themes of the National Student Survey (NSS), section 6 – Learning resources.

Previous studies, NSS and HEIs, identify three major resource categories to enhance students' academic practice: library resources, IT/digital resources, and course-specific resources [15,26,27]. Library resources are literature (hardcopy and digital) made available to support the curriculum [28,29]. These can include the material and access to material such as databases for journal articles, conference papers, and databases, statutory and professional publications, to name a few. IT resources are defined as expertise and knowledge in hardware, software and other technical knowledge that support the academic framework in HE [30–32]. These resources include infrastructure, equipment, operating systems and other digital platforms. Course-specific resources are directly related to the course students are studying, and those cannot be categorised under IT and library resources [33–35]. These resources can be course-specific equipment (such as labs and other course-related equipment), discipline-related software, and collections of BE-related facilities to improve students' academic performance in HE curricula.

The library resources have been the primary source of support available to learners and are highly utilised by academics in teaching within HE curricula. However, the current shift in digitalisation influenced libraries to transition from conventional knowledge hubs to cloud-oriented e-learning spaces [29]; Ali et al., 2021). The focus was on integrating library resources into existential learning resources in HE. One of the significant implementations is allocating library-centric reading lists made available on modules delivered in curricula. Nonetheless, improvement is eminent in transitioning conventional library support to provide learners with better accessibility and awareness (Ali et al., 2021). The literature recognises the proportionality in developing learner performance and progression with library resources [36]. The library resources must be effectively managed so all its' users would easily discover

knowledge content and be easily accessible in delivering resources across all users. Library resources have been integrated into learning management systems to enhance student learning. However, there seems to be limited awareness of how library resources are utilised to promote accessibility and document student progression [28]; Ali et al., 2021). Conversely, studies highlight the limited use of library resources within the student communities and a critical need to create awareness of library resources.

The COVID pandemic has forced digital and virtual learning into mainstream global higher education curricula [31,32]. Digitisation has enabled much-needed flexibility and inclusivity within HE curriculum design in delivering module content. Promoting module availability and accessibility through different means was prominent during the pandemic learning period [37,38]. Academic institutions focused on developing module content and providing supporting facilities incorporating various digital devices such as mobile phones, tablets, and conventional laptops. Thus, Information Technology (IT) was an influential factor in catering for the facilities of academic curricula and providing support through academic resources. The literature recognises many challenges in providing IT resources and facilities to support HE learning [39]. A critical challenge was the inadequate knowledge, competence and expertise in developing quality teaching and learning resources based on IT systems [31,37,40]. Many academics find it overwhelming to operate software through Cloud-platforms prior to the pandemic. Likewise, learners cannot bear many HEIs software system requirements due to the requirements of high-performing devices to function and limitations in freely available content [41]. Thus, critical focus requires identifying the availability and accessibility of software use, ensuring learner support within the HE context.

Since the HE has equal weight given to practical elements reflecting the appropriate learning sector, many external resources are needed to deliver the knowledge content. Critical focus is required for course-specific resources to develop learners' professional competence and align professionalism and proficiency within the desired discipline [42]; Finlay et al., 2022). Enhancing learner opportunities and aligning the industry standards to learner competence is crucial according to Professional, Statutory and Regulatory Bodies (PSRBs). There is a distinctive learning practice and very specific curricular requirements from the HE context that demands critical requisite from academics and HEIs (Finlay et al., 2022). Thus, the learning practice and specific curriculum further require support from the course-specific resources. Resources such as material labs, automated stimulators, Course-specific equipment and tools, collaborative software and platforms, and Virtual/Augmented Reality in modelling can be given as the best examples of course-specific resources in disciplines such as Engineering, Built Environment, Computer, Medicine and Nursing Education [34,35, 43]. It is of significant importance that academic institutions acquire such course-specific resources and be allocated staff with competent knowledge of how to use them. Furthermore, using these course-specific resources is a primary consideration in engaging learners in HE, which is a critical issue in the current learning context.

The NSS data signifies a much need improvement in the learning resources used in the HE curricula [15]. Additionally, prominent literature recognises a crucial attempt to create further awareness of learning resources to enhance student performance [8,10,13]. However, the study identified the root of the above issues are a significant knowledge gap in providing a globalised overview of using learning resources to enhance learning and teaching in HE. Therefore, the aim of the study is to provide a generalised understanding of the current research carried out within the said theme. A scientometric analysis is carried out to achieve the aim of the study by identifying prominent research authors, organisations/institutes, research-led countries and current research trends. The structure of the study will be based as follows; Section 3.0 – materials and methods present the methodology of the study; 4.0 - results and discussion will discuss the data obtained from the study detailing the Scientometric analysis; and Section 5.0 – conclusion and research direction providing a summary of the study's findings and potential future research trends.

3. Material and methods

3.1. Research design

Science mapping visually represents the relationships between disciplines, fields, specialities, and individual articles or authors [44]; Small, 1999). A scientometric analysis has now evolved into an extensive bibliometric analysis where the primary goal is to monitor and identify relationships in scientific topics and define study areas to evaluate their cognitive structure and evolution [45, 46]; Noyons, Moed, & van Raan, 1999). Thus, scientometric analysis is used within the study to quantify and analyse the potential trends of publications indexed accurately. Consequently, the research is designed to coherently map the relationships of authors, institutions, countries and research hotspots along the themes of learning resources in HE.

To carry out the scientometric analysis, firstly, a literature review is carried out to recognise the current context of the research theme. From a methodological standpoint, literature reviews can be described as content analysis, combining quantitative and qualitative features to analyse structural (descriptive) and content criteria [46]; Brewerton & Millward, 2001). A four steps process model, proposed by Mayring (2021), was followed, and it includes:

1. Collection of defined and specified materials: The data to be gathered is. In addition, the unit of analysis (the single publication) is established.
2. Evaluation of formal features of the material, such as the number of publications each year, laying the groundwork for further theoretical research.
3. Structural dimensions and related analytic categories are chosen for application to the acquired data.
4. The material is evaluated based on its structural dimensions, which allows for the identification of significant issues and the interpretation of outcomes.

From the above, potential research gaps and frontiers of knowledge are being identified to determine further the current context of
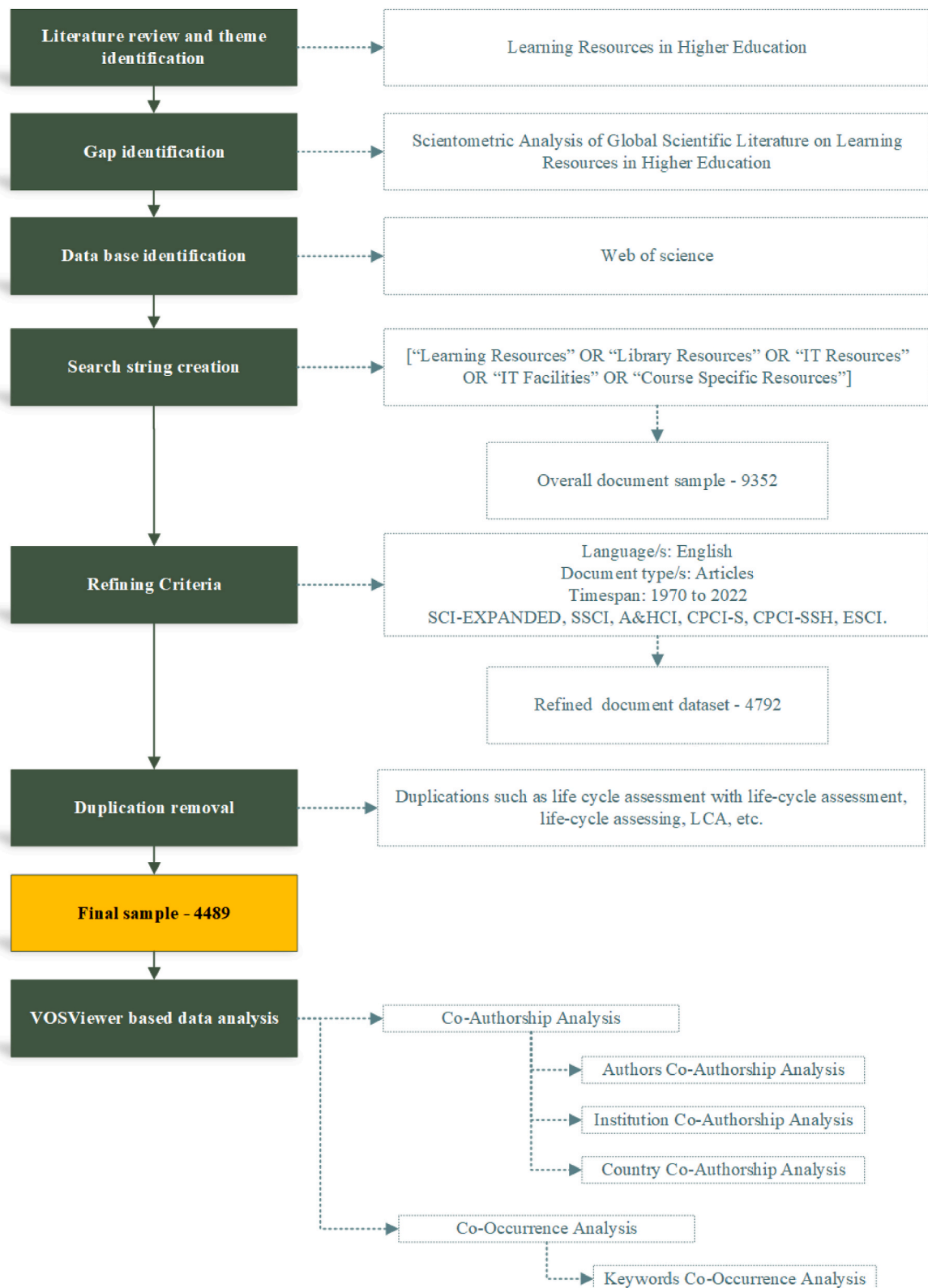
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Fig. 1. Adopted methodology of the study.

research carried out within the theme. An additional brainstorming session was carried out, reflecting on the literature review to identify critical parameters for the search string. Four iterations of datasets were screened to identify the best search string to generate relevant articles for the study. The manual screening was carried out in all the iterations to determine whether the articles were appropriate to the study. Aligning with the best practice in carrying out scientometric studies in previous studies [47], PRISMA guidelines were followed and used to validate the research procedure used in the study. After the dataset iterations and initial screenings, the search string for the study was finalised. Articles generated from the search string were used for the Scientometric analysis. Identification of the articles and database, screening and filtration process, inclusion-exclusion criteria and analysis were carried out as per the recommendations provided by PRISMA guidelines. Fig. 1 provides a detailed description of the methodology of the study, illustrating the research process and data analysis.

3.2. Research procedure

Web of Science was used as the main collection database for the scientometric study, using keywords suggested by the authors during a brainstorming session with critical themes identified from the literature review. The use of Web of Science over other scientific databases is its' reputation for high-quality articles, better citation matching algorithm and lesser duplications within the articles in the database (Chavarro et al., 2018; [48]). These were search phrases deemed necessary for this study to collect the maximum amount of information while adhering to the intended scope. The keywords were selected by identifying author keywords from prominent literature available through the database and carrying out a brainstorming session by authors to select the most influential keywords for the study. During the brainstorming session, four iterations of datasets with different search strings were downloaded and manually screened to recognise the appropriateness of the articles used within the study. After the fourth iteration, the most appropriate search string was recognised (as given below) and used for the scientometric analysis. Themes under the NSS section 6 – learning resources were also considered and incorporated into the study's keyword selection. It is worth noting that these search phrases were connected using the Boolean "OR" logic, with articles published between 1970 and December 2021 in this area. The phrases were searched by topic, covering each article's title, abstract, and keywords to cover as much material as possible. After the four initial screenings with prior datasets, the keywords to be used in the search string for the study were deemed as: TOPIC: ("Learning Resources" OR "Library Resources" OR "IT Resources" OR "IT Facilities" OR "Course Specific Resources"). Refined by: Languages: (English) and Document Types: (Articles); Timespan: 1970 to 2021. SCI-EXPANDED, SSCI, A&HCI, CPCI–S, CPCI-SSH, ESCI. The search was conducted in January 2022, and 4489 articles were obtained as the bibliometric dataset for this study. As detailed below, full articles were downloaded for analysis in text file and excel formats. The text file format is intended for the software used to generate the Scientometric analysis, whereas the excel file was used to identify duplications within the downloaded dataset. The duplications identified from the excel file were corrected in the text files and then fed into the VOSviewer software for the scientometric analysis.

3.3. Data analysis

A freely available software known as the VOSviewer (version 1.6.17), developed by Eck & Waltman (2010), was used for the scientometric analysis carried out in the study. VOSviewer software is particularly used for its high-responsive graphical representation, which promotes clarity in the generated bibliometric maps (Orduña-Malea and Costas, 2021; Leydesdorff, Carley and Rafols, 2012). The software is particularly useful in merging activity-yielding and relationship-indicator analysis, which is predominant in conducting scientometric analyses. Thus, VOSviewer was used to develop the network mapping of 1.) co-authorship of authors, 2.) co-
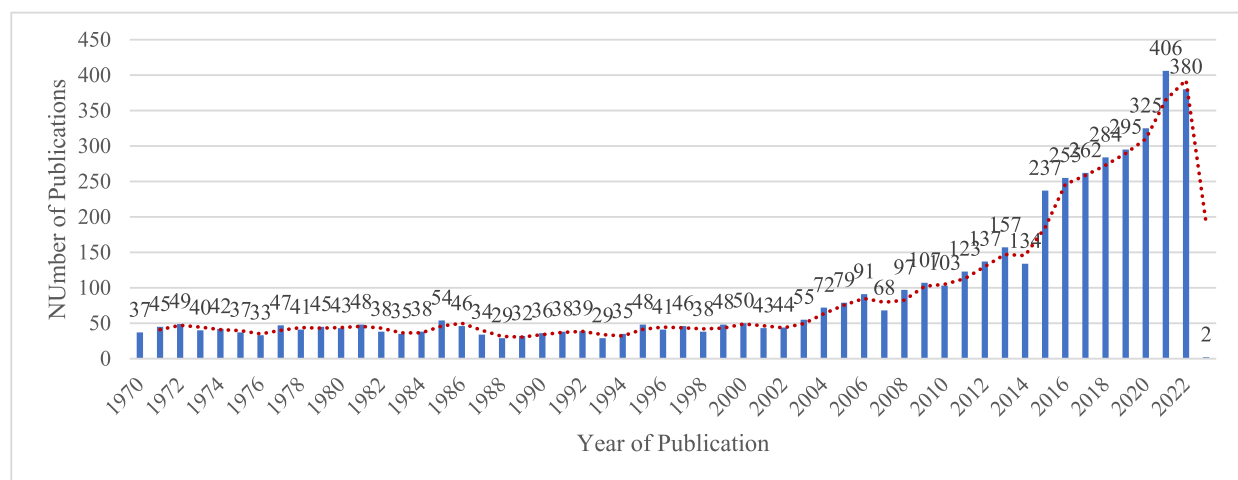

Fig. 2. Number of publications from 1970 to 2022 in the Web of Science.

authorship of organisations/institutions, 3.) co-authorship of countries, and 4.) co-occurrence of keywords. The network maps developed could be interpreted as knowledge maps in understanding the research impact of HE learning resources as it illustrates the most productive authors, influential institutions, significant countries and research trends in HE learning resources [45,46]. All network maps were developed by selecting an appropriate threshold and adjusting the visualisation scale and size variation that provides the clearest network map. The threshold will be denoted at each section of the analysis. Overall, the node's size determines the contribution made, and the lines represent their level of relatedness. The colour in co-authorship signifies the similarity and the relationship, while in co-occurrence, it signifies the year of publication.

4. Results and discussion

The 4489 published research articles obtained from the initial screening were analysed, and Fig. 2 illustrates the frequency of research articles published in the "learning resource" domain. The figure signifies the research output and the increase of research in learning resources within academia. There seem to be limited publications (i.e. no more than 50 publications per year) from 1970 to 2000 within the research domain, although some spike was noticed in 1985. However, an increase is evident from 2000 to 2016 due to the context of e-learning facilities and digitisation being implied and facilitated within HE environments (Vinichenko, 2018; Elfirdoussi, 2020). Also, the COVID-19 pandemic brought new insight into contextualising module delivery and promoting learning resources digitally (Elfirdoussi, 2020; Fabriz, 2021). The study confirms this trend as it identified no negative impact of COVID-19 on research, as some of the highest publications were from 2019. The year 2022 recorded the most articles published with 406 entries, and the decrease in 2023 records is due to incomplete bibliographic data records. The records indicate that the number of publications will continue to increase in the coming years.

4.1. Co-authorship analysis

Co-authorship mapping is one of the most popular functions of conducting a scientometric analysis. The co-authorship network mapping and analysis identify scientific collaborations and connect behavioural patterns through a reliable algorithm [49]; Oladinrin et al., 2021). The behavioural pattern obtained by co-authorship analysis can be mainly categorised concerning authors, researchers, organisations and countries. The analysis assists in identifying the significant collaborative structures with prominent researchers, areas of prominent focus within the subject field, and the centrality of network participants and offers insight into further areas of study (Oladinrin et al., 2021; [50]. It recognises organisations' and nations' involvement and participation in driving research forward within the subject area. Thus, the study uses co-authorship analysis to create a network mapping of authors, organisations and countries to comprehend research collaboration within the "Learning Resources in HE" subject area.

When developing the co-authorship mapping, a nominal threshold is selected for the categories of authors, organisations, and countries. This clarifies and avoids overlaps to enhance readability within developed network visualisation by eliminating authors/organisations/countries with fewer articles. The appropriate threshold is selected by running several iterations and identifying the visualisation that provides the best clarity. Articles with multiple authors, organisations and from different countries are counted in full rather than proportionally to further understand their influence denoted by their link strength. Any eliminations or removals will be discussed under each section as appropriate and given reasons.

4.1.1. Authors

A total number of 10,828 research authors were identified from the 4489 published bibliographic research articles. Anonymous articles and authors were removed to avoid confusion with the dataset obtained. Subsequently, 43 authors were identified who met the threshold of a minimum 6 number of documents for each author. The corresponding number of total publications, citations, and their link strength with other authors were calculated and presented in Table 1. The data further illustrate the institution and the country associated with each author. This data prove insightful in identifying each of their influence, considering the number of publications and citations and their strength in collaborating with other authors and signposting their co-authorship within the research area.

Table 1
The top 13 most productive institutions.

Author	Institution	Country	Total Publication	Citations
Salamin, N.	University of Lausanne	Switzerland	20	487
Jayaraman, A.	University of Delaware	USA	16	153
Janotti, A.	University of Delaware	USA	15	240
Litsios, G.	University of Lausanne	Switzerland	12	342
Chan, I.	Konkuk University	South Korea	12	34
Hwang, G.	National Taiwan University of Science and Technology	Taiwan	10	762
Sanchez-Alonso, S.	University of Alcala	Spain	9	95
Zullo, T.G.	Seton Hill University	USA	9	450
Decker, S.	Missouri State University	USA	8	491
Pearman, P.B	University of the Basque Country	Spain	8	220
Simeonidou, D.	University of Bristol	England	8	116
Azer, S.A.	King Saud University	Saudi Arabia	8	427
Frary, R.B.	Virginia Polytechnic Institute and State University	USA	8	332

Salamin, N. of the University of Lausanne in Switzerland produced the highest number of publications (20) and citations (487). Jayaraman, A. and Janotti, A. of the University of Delaware in the USA produced the second and third-highest publications (16 & 15) and citations (153 & 240), respectively.

The presented data signifies that most of the authors are from the USA, indicating the influence of research and incentive on learning resources in higher education. It further recognises the focus on learning resources in HE, indicating the extent of effort in research-driven pedagogical implementation. This further clarifies how they are at the forefront of pedagogical advancements such as virtual and augmentation in learning, contemporary teaching environments, and neoliberalism in HE contexts.

Fig. 3 illustrates the network visualisation of the highly productive authors. One of the significant findings from the study is that the lack of collaboration between research-active authors within the theme of learning resources in HE stands out in the analysis. The VOSViewer identified cluster-based collaboration between authors without a substantial network among them. Interestingly, some authors are not collaborative, even with a similar demographical underpinning. The lack of collaboration from such a level results in a significant gap in enhancing learning resources in HE curricula.

Fig. 4 identified the highest collaboration among the authors in the dataset with eight prominent authors. These authors had 8 documents collaborated between them with a minimum threshold of 6 documents for each author. Although Fig. 4 represents the highest number of collaborated authors within the theme, it does not represent the global perspective of research carried out in learning resources in HE. This further highlights the lack of research interest in the theme, although it is a prominent aspect of student performance and progression.

4.1.2. Organisations/institutions

As there are many institutions across the global research context, Table 2 presents the top 9 most productive institutions with a stronghold on research in learning resources in HE. Out of the 3272 organisations identified from the bibliographic data, only 41 organisations met the threshold of 15 documents per organisation. The analysis provides further insights into the number of publications per organisation and their geographic location to identify the best-performing research institutions. The topmost research-active organisation on HE learning resources was identified as the University of Illinois, with 61 research article publications. The University of Delaware and Pittsburgh rank second and third, having 55 and 42 publications. It is also interesting that the USA accommodated most institutes with more research focus on learning resources in the HE context. This replicates the study's previous findings where the USA accommodates more research-active authors (section 3.1.1) and being at the forefront of research (section 3.1.3) in learning resources in higher education.

The network visualisation map, Fig. 5, identifies the research collaboration within organisations with a minimum of 15 documents
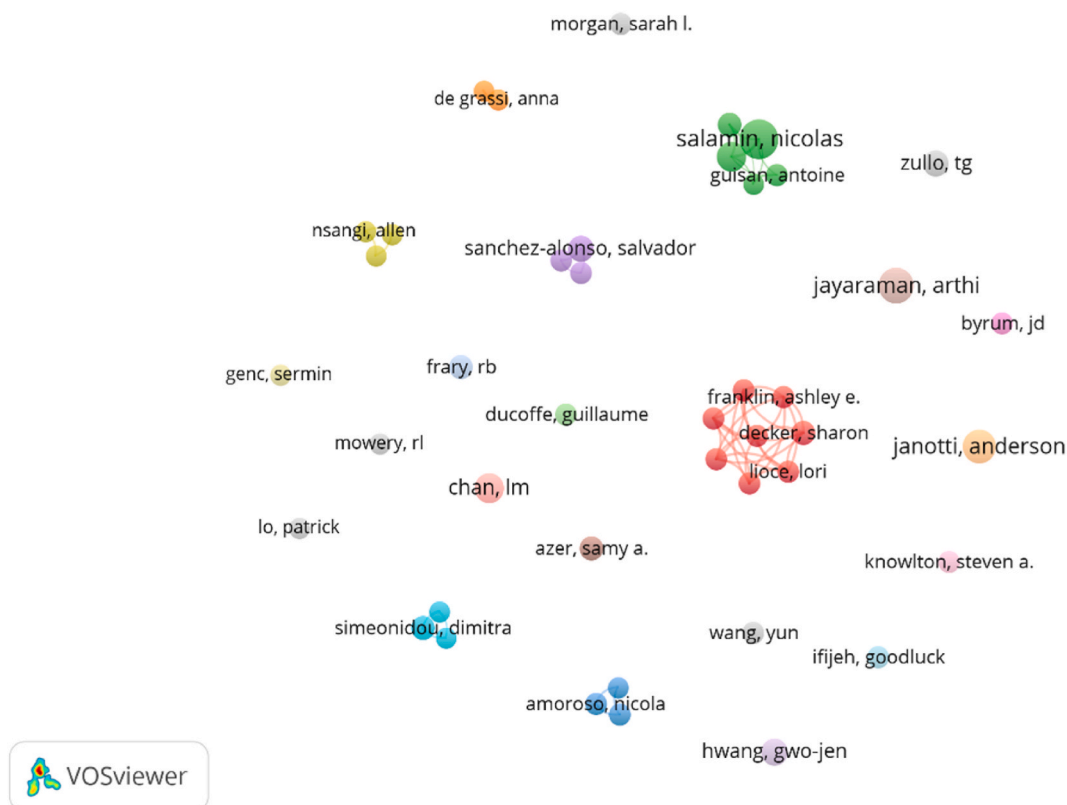

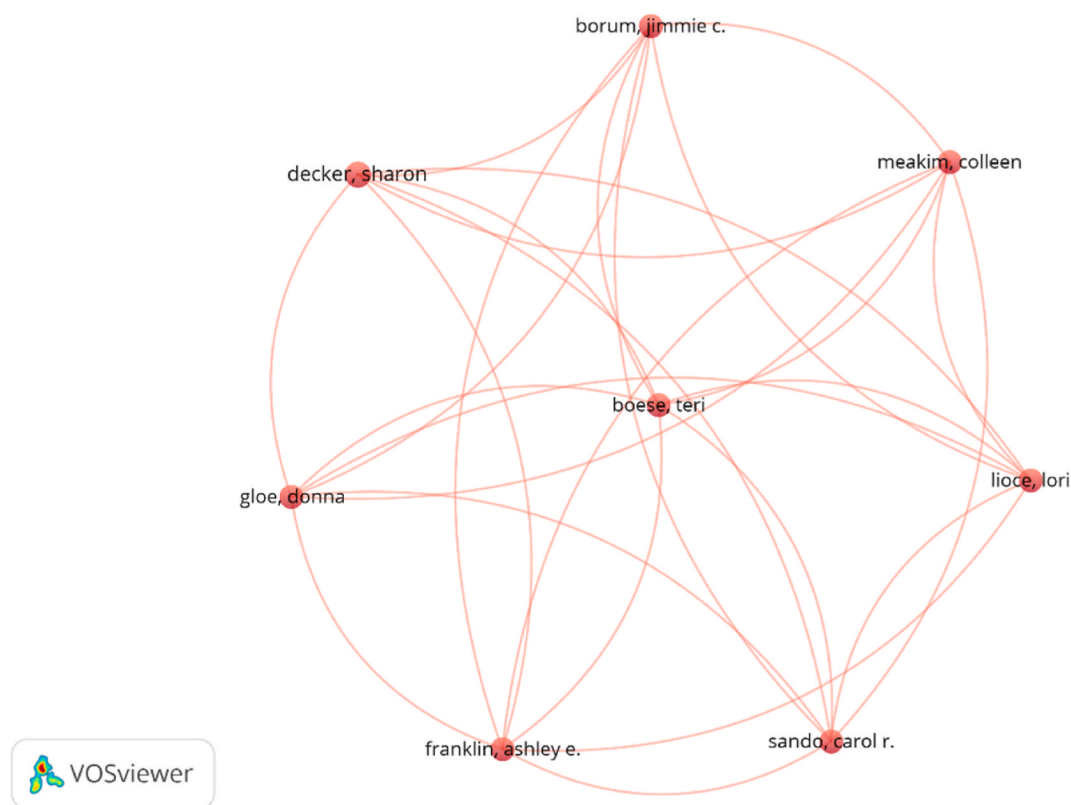**Fig. 3.** Network visualisation of highly productive authors.

Fig. 4. Network visualisation of highest collaborated authors.

Table 2
The top 9 most productive institutions.

Institution	Country	Total Publication	Citations
University of Illinois	USA	61	749
University of Delaware	USA	55	775
University of Pittsburgh	USA	42	974
University of Colorado	USA	34	1277
University of California Irvine	USA	31	85
University of Florida	USA	26	706
University of Lausanne	Switzerland	26	513
University of Toronto	Canada	26	579
University of Sydney	Australia	25	220

per organisation. The close proximity and the lines denoted illustrate how each institution accounts for a collaboration. It can be seen that most of the institutions from the USA and some institutions originating in Hong Kong, Canada, and Australia are closely clustered. In contrast, institutions originating from the UK, Europe, and Asia are clustered separately. It shows that the two clusters have successfully established networks and collaboration. However, the study does not illustrate any other institutions apart from the above listed within the network visualisation. Especially the network visualisation is not represented by any developing country. This indicates a significant need for either strong collaborations or more research focus within the research theme. Institutes that are already having good collaboration must ensure to broaden their research relationships to facilitate further collaboration. Institutes, especially in developing countries, must further strengthen their collaboration by liaising with the most prominent institutions mentioned below.

4.1.3. Countries

113 countries contributed to the retrieved research articles analysed within the study. However, only 29 countries met the threshold of 25 publications per country. The ten most research-prolific countries are denoted in Table 3, and the study revealed that the USA has a significant input on research published with 1662 publications. It could be further identified that China follows with 338 publications, England with 332, Australia with 248 and Canada with 197 publications. The study reveals that the USA has more influence and emphasis on research in learning resources and is further engaging and increasing its research output. This can be mainly due to good research backing and infrastructure for research within the field [51]. The data revealed that contributions from both
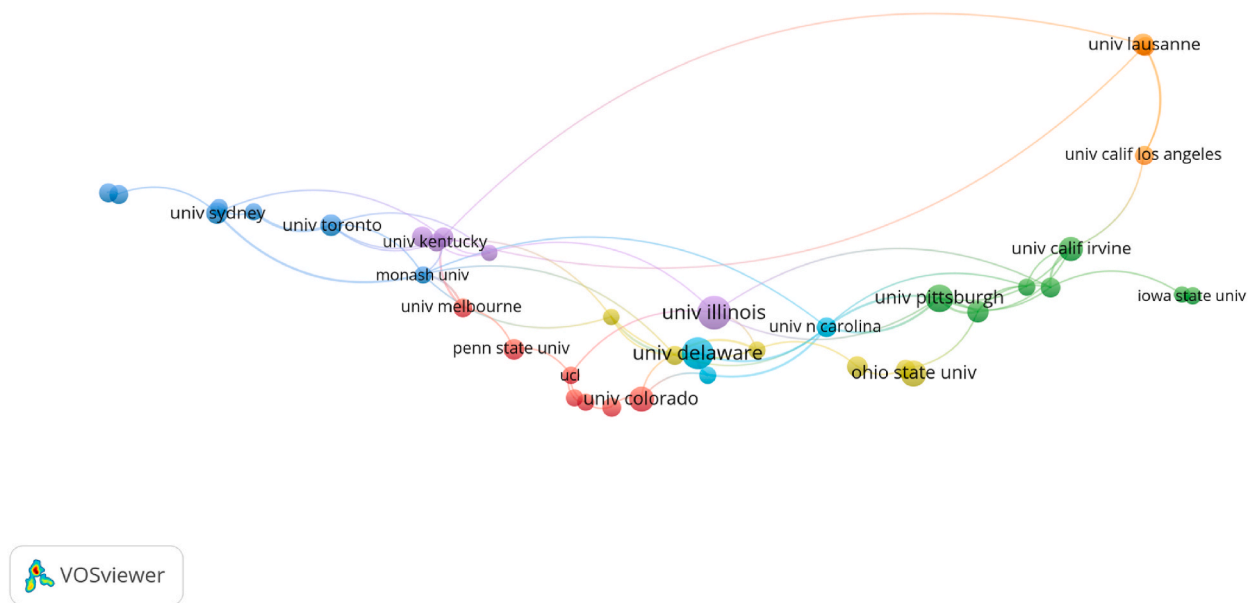
Fig. 5. Network visualisation of contributing organisations.

Table 3
The top 10 most participating countries.

Country	Total Publication	Citations	Total Link Strength
USA	1662	23324	256
China	338	3625	164
England	332	6397	202
Australia	248	4855	139
Canada	197	3216	107
Spain	126	1794	95
India	109	744	40
Taiwan	99	2188	35
Italy	87	1676	72
Germany	84	2067	84

developed and developing nations significantly impacted the retrieved research articles. However, secondary data screenings recognise the need for digital and cloud-based learning resources that are yet to be further investigated in developing nations. The research was eminent on the impact of COVID-19 on developed and developing nations. However, a major focus of developing nations was the lack of technology, whereas the developed nations focussed more on developing offsite and the accessibility of learning resources.

Fig. 6 illustrates the network collaboration map of countries. The 29 countries were identified with a threshold of 25 documents per country and are distributed with four main clusters denoted by different colour themes. Interestingly, the clusters denote the USA and other Asian and Asia-pacific countries in one cluster, the UK and European countries in one cluster, India and Brazil in one cluster, and other Asian and Middle-Eastern countries in the remaining cluster. Data indicates that the USA has more strength in collaboration while the UK and the Europan countries have a wider collaboration. As the thickness of the line indicates the strength of collaboration, this study recognises the following pairs of countries with the most significant collaboration.

A critical takeaway is that collaboration is more centralised in research-led countries than in institutions (Fig. 5). The network visualisation signifies that collaboration is successful at the country level rather than at an institutional level. Although the research is carried out on a cluster basis, there is representation from developed and developing regions. This entails a global perspective of research being collaborated and carried out within learning resources in the HE. However, an in-depth analysis needs to be carried out to assess the regional focus of the research to understand the extent of collaboration.

4.2. Co-occurrence: keywords

Co-occurrence network diagrams help understand the frequency in which the keywords occur in a particular setting. Co-occurrence analysis has many uses, such as text-mining, which counts how frequently the texts have appeared throughout the years [52,53]. Thus, co-occurrence networks were predominantly used to identify research trends by analysing the keywords used in research articles.
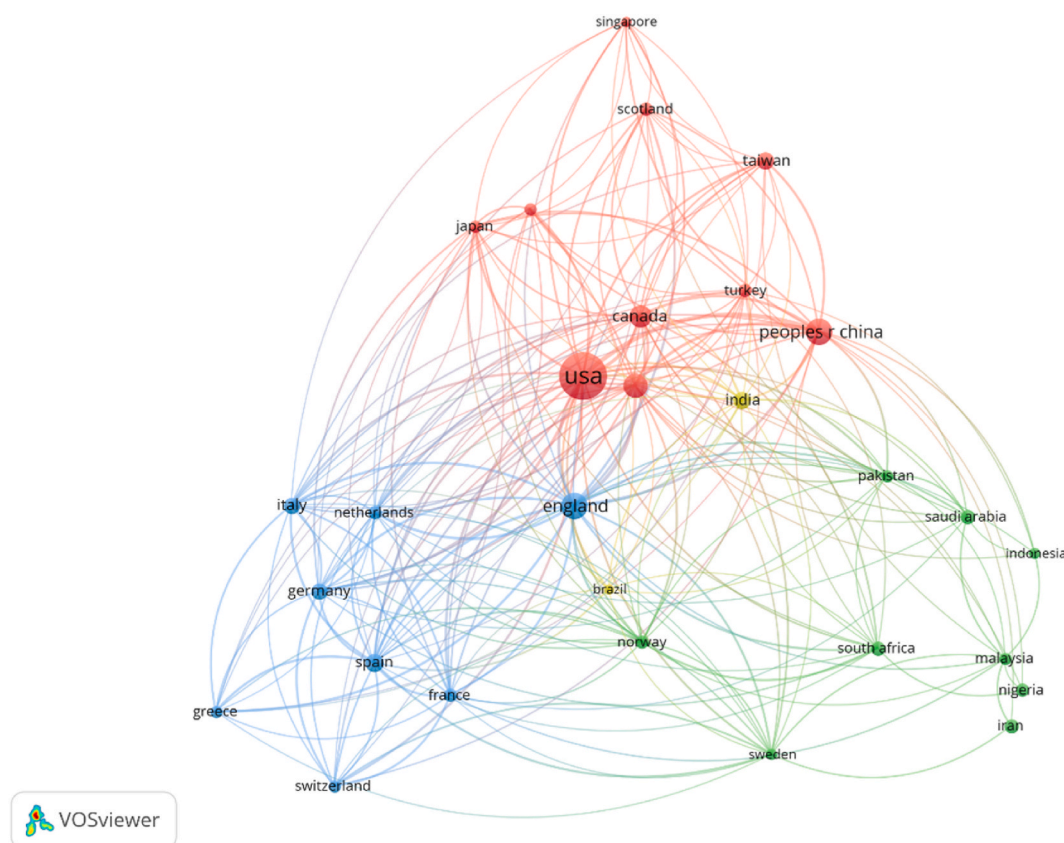
Fig. 6. Network visualisation of countries.

For this study, 29 keywords were obtained when the threshold was provided at 20 occurrences from 4489 articles, as presented in Table 4. The most popular keywords can be identified as e-learning, education, academic libraries, learning resources and cloud computing. The search criteria include the keywords "education" and "learning resources" the data has been replicated and is included in the co-occurrence analysis. E-learning has been prominent, with 152 occurrences within the dataset. This is expected due to the HE curricula's influence and inclination towards digital learning contexts. Closely looking into the academic library context within the dataset, it can be identified that this mostly focuses on digital-academic libraries. Again signposting the influence of digitisation on the HE learning context. One new research trend emerging from keyword co-occurrence analysis is using cloud-based computing within HE learning contexts. There are significant articles on using cloud-based software and data as learning resources, especially in computing and IT-related HE curricula. However, the studies identify that cloud-based technology is still to be implemented and fully utilised in most HE disciplines, especially in nursing, the built environment, and agriculture. Fig. 7 presents the frequency of keywords obtained from the bibliographic data and their link strength alongside the timeline. This illustration provides further insights into the co-occurrences of each keyword, revealing the research focuses throughout the selected timeline.

The five strongest keywords were identified as follows, e-learning (with 152 occurrences and a link strength of 78), Education (with 79 occurrences and a link strength of 45), Academic libraries (with 73 occurrences and a link strength of 39), Learning resources (with

Table 4
The top 10 most popular keywords.

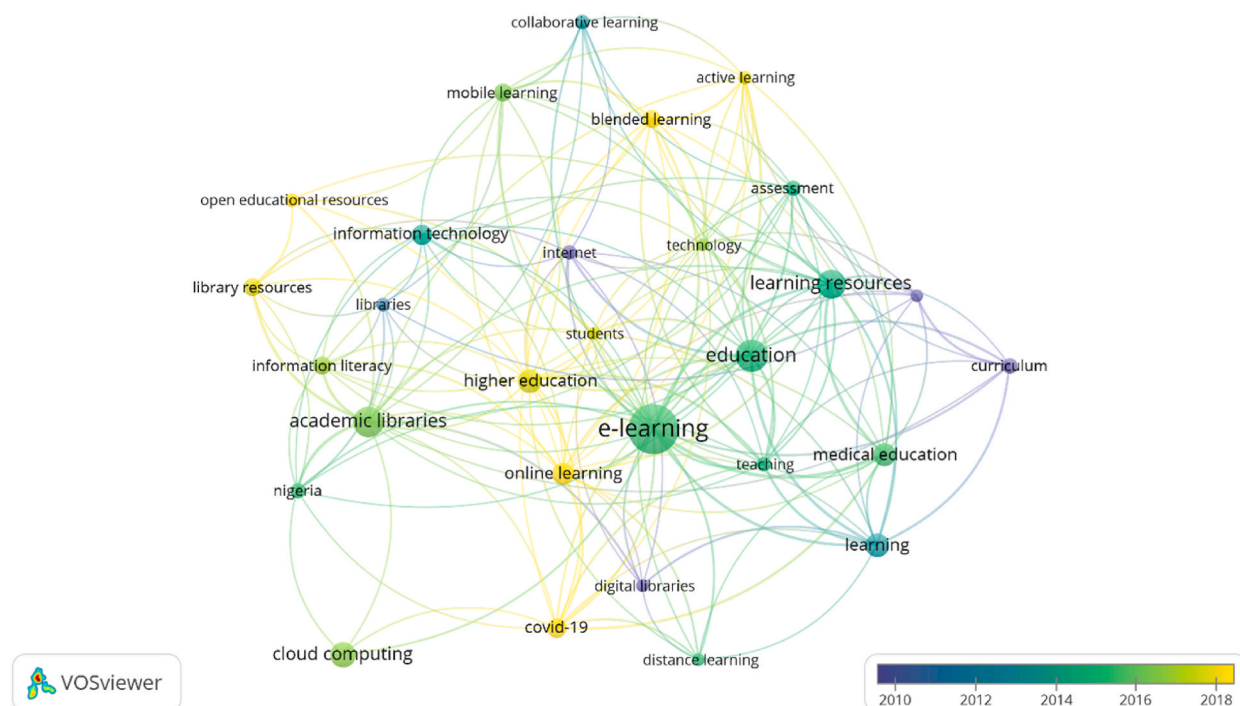| Keyword	Occurrences	Total link strength
e-learning	152	78
Education	79	45
Academic libraries	73	39
Learning resources	67	40
Cloud computing	56	5
Higher education	51	31
Learning	50	39
Online learning	47	30
Information technology	40	13
Covid-19	39	24

Fig. 7. Overlay visualisation of keywords.

67 occurrences and a link strength of 40), and Cloud computing (with 56 occurrences and a link strength of 5). Without considering the keywords used in the search criteria, e-learning, academic libraries, and cloud computing can be identified as prominent areas of research or research hotspots within the theme of learning resources in HE.

Although the above keywords were identified as prominent research areas, the overlay visualisation in Fig. 7 illustrates the use of the keywords according to their average occurrence per year. The purple colour range keywords can be seen near 2010, green nearing 2016, and yellow for 2018 and above. The overlay visualisation categorises keywords such as digital libraries and the internet in the purple range; and e-learning, mobile learning, collaborative learning, cloud computing and information literacy in the green range. The most current keywords in the yellow range are active learning, blended learning, library resources, higher education, COVID-19 and online learning.

Although studies by Refs. [54,55] identified a digital learning paradigm in recent years, overlay visualisation denotes that digitisation has been a part of HE learning resources since (at least) 2010. The visualisation also illustrates the prominent focus on COVID-19, where most teaching and learning in HE transferred online. The study identified that research hotspots such as digital libraries, curriculum, internet, collaborative learning, mobile learning, and cloud computing are becoming obsolete. However, these research hotspots need further emphasis as it underpins the current paradigm shift of digital learning. Additionally, medical education has been listed as the only discipline-specific research area in the overlay visualisation. More discipline-specific research needs to be catered such as management, built environment, engineering, etc., to promote best practices in utilising learning resources within the body of knowledge.

5. Conclusion and research directions

The study aimed to present a scientometric analysis of learning resources in the current HE context. It is viewed as the foundation of an objective analysis of the current research trends and the existing literature under the theme of "learning resources in HE".

Publications about learning resources in HE were limited from 1970 to 1990. Although the research stagnated from 1970 to 2002, there was a gradual rise of articles published from 2003 to 2013, but a significant exponential rise from 2015 to 2022. The lower number of publications in 2023 is due to the incomplete record. One of the most significant findings was limited collaboration between authors regarding the study of HE learning resources. As per the co-author's analysis, the link strengths in all the authors were very low across the dataset, indicating very low collaboration among authors. Salamin, N. of the University of Lausanne in Switzerland, was identified as the most productive author with 20 publications and 487 citations. The topmost research-active institution was the University of Illinois, with 61 total research article publications, and the USA has a significant research output as a country with 1662 publications. A lack of institutional collaboration between developed and developing regions' demographics was also identified. The co-occurrence analysis illustrated the current research hotspots: e-learning, Education, Academic libraries, Learning resources, and Cloud computing. Even though the findings are recorded above, they should be carefully inferred to avoid misinterpretation in the

current research context and future research trends.

Some key takeaways and trends were identified from the study, signifying the study's novelty. Evidence is presented on increasing studies on learning resources in HE. The significant rise in publications on the theme in the later years can be due to the COVID-19 pandemic resulting in an online teaching transition in learning. The study revealed that this is a common misconception where digitisation has been a part of the research theme since 2010. However, the most significant issue is the lack of collaboration between authors related to research on learning resources in HE. A significant decrease and a very limited link strength were identified among the authors during the co-authorship analysis. Data suggests that research is being carried out more individually and that limited knowledge is shared between researchers within the area. It correlates with the co-authorship analysis of counties as there seems to be a very limited collaboration between each other. Collaboration and at least facilitation to collaborate are eminent in both research-led institutions and institutes based in developing regions. This must be addressed swiftly to encourage best practices and enhance pedagogical practices within the global HE context. Research carried out in developed countries could be reprised in developing countries to further enhance the learning resources and their utilisation in HE curricula. The USA, which dominated the research output, could take the lead and include more on the other clusters with different origins and practices. The need for a strategic research focus is imminent and must be addressed swiftly to achieve global collaboration. Keywords illustrate that transitioning toward digital approaches in providing learning resources is still a research trend. This could predominantly be due to the recent emphasis on digitation and digitised learning with the COVID pandemic. However, key research trends such as digital libraries, curriculum, internet, collaborative learning, mobile learning, and cloud computing need further emphasis as they underpin the current paradigm shift of digital learning in HE. Moreover, further research needs to be carried out on digitisation, with more cross-sectional and contextualised studies focused on both developed and developing countries.

This study signifies the relationships of authors, institutions, countries and research hotspots within learning resources in HE. It enables academics, researchers, academic institutes and other relevant parties to identify frontiers in research and potential research gaps that need eminent focus. Academics and regulatory bodies could further benefit by utilising the results in enhancing learning resources as denoted by the co-occurrence visualisation presented in the study. One major limitation of the study is the global perspective of publication analysis; future research could benefit from having a more regional focus, especially in developing countries which will be beneficial to understanding the current context of Learning resources in HE accurately. More databases (such as Scopus, etc.) could be used to obtain a broader perspective of the studies carried out. Additionally, more discipline-specific research could be used as this study aimed for a holistic and cross-sectional approach to learning resources in HE. The study recognised a predominant research focus on learning resources within the medical and nursing disciplines. However, more discipline-related research needs to emerge to facilitate the need for research within discipline-specific learning resources. The one critical takeaway from the study is that author collaborations are eminent and need to be significantly improved within the research focus, enhancing the best practices in providing learning resources in a global context. This would lead to the implementation of such best practices to facilitate the effective use and, thus, enhance student satisfaction in using learning resources within the higher education context.

Production notes

Author contribution statement

Kasun Gomis; Olugbenga Timo Oladinrin: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Mandeep Saini: Contributed reagents, materials, analysis tools or data.

Chaminda Pathirage: Contributed reagents, materials, analysis tools or data; Wrote the paper.

Mohammed Arif: Conceived and designed the experiments; Contributed reagents, materials, analysis tools or data.

Data availability statement

Data will be made available on request.

Additional information

No additional information is available for this paper.

References

[1] C. Halbert, R. Kriebel, R. Cuzzolino, P. Coughlin, K. Fresa-Dillon, Self-assessed learning style correlates to using supplemental learning materials in an online course management system, Med. Teach. 33 (4) (2011) 331–333.
[2] M. Baas, W. Admiraal, E. van den Berg, Teachers' adoption of open educational resources in higher education, J. Interact. Media Educ. (1) (2019), 2019.
[3] G. Savić, M. Segedinac, D. Milenković, T. Hrin, M. Segedinac, A model-driven approach to e-course management, Australas. J. Educ. Technol. 34 (1) (2017) 14–29.
[4] M. Wilhelm-Chapin, T. Koszalka, Graduate students' use and perceived value of learning resources in learning the content in an online course, TechTrends 64 (3) (2020) 361–372.
[5] M. Virtanen, E. Haavisto, E. Liikanen, M. Kääriäinen, Ubiquitous learning environments in higher education: a scoping literature review, Educ. Inf. Technol. 23 (2) (2017) 985–998.
[6] S. Alphonce, K. Mwantimwa, Students' use of digital learning resources: diversity, motivations and challenges, Infor. Learn. Sci. 120 (11/12) (2019) 758–772.

[7] S. Aljawarneh, Reviewing and exploring innovative ubiquitous learning tools in higher education, J. Comput. High Educ. 32 (1) (2019) 57–73.
[8] C. Shen, J. Ho, Technology-enhanced learning in higher education: a bibliometric analysis with latent semantic approach, Comput. Hum. Behav. 104 (2020), 106177.
[9] K. Gomis, M. Saini, C. Pathirage, M. Arif, Enhancing the organisation and the management of built environment higher education courses, Qual. Assur. Educ. 31 (2) (2023) 331–345, https://doi.org/10.1108/QAE-01-2022-0020.
[10] Z. Qiang, A. Obando, Y. Chen, C. Ye, Revisiting distance learning resources for undergraduate research and lab activities during COVID-19 pandemic, J. Chem. Educ. 97 (9) (2020) 3446–3449.
[11] M. Wyres, N. Taylor, Covid-19: using simulation and technology-enhanced learning to negotiate and adapt to the ongoing challenges in UK healthcare education, BMJ Simul. Techn. Enhan. Lear. 6 (6) (2020) 317–319.
[12] D. Mulyadi, M. Huda, I. Gusmian, Smart learning environment (SLE) in the fourth industrial revolution (IR 4.0), Int. J. Asian Bus. Inf. Manag. 13 (2) (2022) 1–23, https://doi.org/10.4018/ijabim.287589. Available at:.
[13] B. Bygstad, et al., From dual digitalization to digital learning space: exploring the digital transformation of higher education, Comput. Educ. 182 (2022), 104463, https://doi.org/10.1016/j.compedu.2022.104463. Available at:.
[14] K. Gomis, M. Saini, C. Pathirage, M. Arif, Enhancing Quality of Teaching in the Built Environment Higher Education, Quality Assurance in Education, UK, 2022.
[15] Office for Students, National Student Survey Results 2020, 2020 (London, UK).
[16] M. Händel, M. Stephan, M. Gläser-Zikuda, B. Kopp, S. Bedenlier, A. Ziegler, Digital Readiness and its effects on higher education students' socio-emotional perceptions in the context of the COVID-19 pandemic, J. Res. Technol. Educ. 54 (2) (2020) 267–280, https://doi.org/10.1080/15391523.2020.1846147.
[17] M. Núñez-Canal, M.de de Obesso, C.A. Pérez-Rivero, New challenges in higher education: a study of the digital competence of educators in Covid Times, Technol. Forecast. Soc. Change 174 (2022), 121270, https://doi.org/10.1016/j.techfore.2021.121270. Available at:.
[18] B. Collis, J. Moonen, The contributing student: learners as co-developers of learning resources for reuse in web environments, Engag. Learn. Emerg. Techn. (2006) 49–67, https://doi.org/10.1007/1-4020-3669-8_3. Available at:.
[19] M. Berti, Open educational resources in higher education, Iss. Tren. Educ. Techn. 6 (1) (2018), https://doi.org/10.2458/azu_itet_v6i1_berti. Available at:.
[20] L. Zhang, X. Yu, Intelligent retrieval method of mobile learning resources in the Intelligent Higher Education System, Int. J. Sys. Assur. Eng. Manag. 13 (6) (2021) 3079–3091, https://doi.org/10.1007/s13198-021-01455-7. Available at:.
[21] M. Bond, et al., Emergency remote teaching in higher education: mapping the first global online semester, Int. J. Educ. Tech. Hig. Educ. 18 (1) (2021), https://doi.org/10.1186/s41239-021-00282-x. Available at:.
[22] A.M. Maatuk, et al., The COVID-19 pandemic and e-learning: challenges and opportunities from the perspective of students and instructors, J. Comput. High Educ. 34 (1) (2021) 21–38, https://doi.org/10.1007/s12528-021-09274-2. Available at:.
[23] IBE-UNESCO, Learning Resources, International Bureau of Education, 2016. UNESCO. Available at: http://www.ibe.unesco.org/en/glossary-curriculum-terminology/l/learning-resources. (Accessed 2 January 2023). Accessed.
[24] J.E. Seaman, J. Seaman, *Inflection Point: Educational Resources In U.S. Higher Education, 2019*. Rep, Bay View Analytics, Oakland, California, 2020, pp. 2–5.
[25] Department for Employment, Learning, The UK Professional Standards Framework for Teaching and Supporting Learning in Higher Education, The Higher Education Academy, York, 2011. Heslington.
[26] W. Beyene, A. Mekonnen, G. Giannoumis, Inclusion, access, and accessibility of educational resources in higher education institutions: exploring the Ethiopian context, Int. J. Incl. Educ. (2020) 1–17.
[27] S. Fabriz, J. Mendzheritskaya, S. Stehle, Impact of synchronous and asynchronous settings of online teaching and learning in higher education on students' learning experience during COVID-19, Front. Psychol. 12 (2021).
[28] M. Oakleaf, The problems and promise of learning analytics for increasing and demonstrating library value and impact, Inf. Learn. Sci. 119 (1/2) (2018) 16–24.
[29] H. Chan, L. Chan, Smart library and smart campus, J. Serv. Sci. Manag. 11 (6) (2018) 543–564.
[30] P. Paudel, Online education: benefits, challenges and strategies during and after COVID-19 in higher education, Int. J. Stud. Educ.(IJonSE) 3 (2) (2021) 70–85.
[31] A. Shahzad, R. Hassan, A. Aremu, A. Hussain, R. Lodhi, Effects of COVID-19 in E-learning on higher education institution students: the group comparison between male and female, Qual. Quantity 55 (3) (2020) 805–826.
[32] O. Chernikova, N. Heitzmann, M. Stadler, D. Holzberger, T. Seidel, F. Fischer, Simulation-based learning in higher education: a meta-analysis, Rev. Educ. Res. 90 (4) (2020) 499–541.
[33] C. Viegas, A. Pavani, N. Lima, A. Marques, I. Pozzo, E. Dobboletta, V. Atencia, D. Barreto, F. Calliari, A. Fidalgo, D. Lima, G. Temporão, G. Alves, Impact of a remote lab on teaching practices and student learning, Comput. Educ. 126 (2018) 201–216.
[34] P. Gazarian, J. Cronin, I. Jahng, S. Tapalyan, Use of course-specific open educational resources in a graduate nursing course, J. Nurs. Educ. 59 (10) (2020) 577–580.
[35] O. Zlatkin-Troitschanskaia, J. Hartig, F. Goldhammer, J. Krstev, Students' online information use and learning progress in higher education – a critical literature review, Stud. High Educ. 46 (10) (2021) 1996–2021.
[36] R. Nurse, K. Baker, A. Gambles, Library resources, student success and the distance-learning university, Inf. Learn. Sci. 119 (1/2) (2018) 77–86.
[37] R. Burns, A COVID-19 panacea in digital technologies? Challenges for democracy and higher education, Dialog. Hum. Geog. 10 (2) (2020) 246–249.
[38] S. Elfirdoussi, M. Lachgar, H. Kabaili, A. Rochdi, D. Goujdami, L. El Firdoussi, Assessing Distance Learning in Higher Education during the COVID-19 Pandemic, vol. 2020, Education Research International, 2020, pp. 1–13.
[39] M. Suleiman, A. Yahya, M. Tukur, Effective utilisation of ICT tools in higher education, J. Xidian Univ. 14 (9) (2020).
[40] S. van der Linden, J. van der Meij, S. McKenney, Teacher video coaching, from design features to student impacts: a systematic literature review, Rev. Educ. Res. 92 (1) (2021) 114–165.
[41] D. Mehta, X. Wang, COVID-19 and digital library services – a case study of a university library, Dig. Libr. Persp. 36 (4) (2020) 351–363.
[42] M. Vinichenko, A. Kirillov, A. Maloletko, E. Frolova, M. Vinogradova, Motivation of university authorities aimed at creating favorable learning environment in the course of restructuring higher education institutions, Eurasia J. Math. Sci. Technol. Educ. 14 (5) (2018).
[43] M. Finlay, D. Tinnion, T. Simpson, A virtual versus blended learning approach to higher education during the COVID-19 pandemic: the experiences of a sport and exercise science student cohort, J. Hospit. Leisure Sports Tourism Educ. 30 (2022), 100363.
[44] O. Oladinrin, K. Gomis, W. Jayantha, L. Obi, M. Rana, Scientometric analysis of global scientific literature on aging in place, Int. J. Environ. Res. Publ. Health 18 (23) (2021), 12468.
[45] K. Gomis, R. Kahandawa, R.S. Jayasinghe, Scientometric analysis of the global scientific literature on circularity indicators in the construction and Built Environment Sector, Sustainability 15 (1) (2022) 728, https://doi.org/10.3390/su15010728. Available at:.
[46] L. Wang, X. Xue, Y. Zhang, X. Luo, Exploring the emerging evolution trends of urban resilience research by scientometric analysis, Int. J. Environ. Res. Publ. Health 15 (10) (2018) 2181, https://doi.org/10.3390/ijerph15102181.
[47] J.-A. Marín-Marín, et al., Steam in education: a bibliometric analysis of performance and co-words in web of science, Int. J. STEM Educ. 8 (1) (2021), https://doi.org/10.1186/s40594-021-00296-x. Available at:.
[48] J. López-Belmonte, A. Segura-Robles, A.-J. Moreno-Guerrero, M.-E. Parra-González, Projection of E-learning in higher education: a study of its scientific production in web of science.European journal of investigation in health, Psych. Educ. 11 (1) (2021) 20–32, https://doi.org/10.3390/ejihpe11010003.
[49] A. Kastrin, D. Hristovski, Scientometric analysis and knowledge mapping of literature-based discovery (1986–2020), Scientometrics 126 (2) (2021) 1415–1451.
[50] J. Fagan, K.S. Eddens, J. Dolly, N.L. Vanderford, H. Weiss, J.S. Levens, Assessing research collaboration through Co-authorship network analysis, J. Res. Adm. 49 (1) (2018) 76–99.
[51] N. Colvard, C. Watson, H. Park, The impact of open educational resources on various student success metrics, Int. J. Teach. Learn. High. Educ. 30 (2) (2018) 262–276.
[52] S. Lozano, L. Calzada-Infante, B. Adenso-Díaz, S. García, Complex network analysis of keywords co-occurrence in the recent efficiency analysis literature, Scientometrics 120 (2) (2019) 609–629.

[53] F. Cheng, Y. Huang, H. Yu, C. Wu, Mapping knowledge structure by keyword co-occurrence and social network analysis, Libr. Hi Technol. 36 (4) (2018) 636–650.

[54] J. Koh, R. Kan, Students' use of learning management systems and desired e-learning experiences: are they ready for next generation digital learning environments? High Educ. Res. Dev. 40 (5) (2020) 995–1010.

[55] L. Hassell, J. Peterson, L. Pantanowitz, Pushed across the Digital Divide: COVID-19 Accelerated Pathology Training onto a New Digital Learning Curve, vol. 8, Academic Pathology, 2021, 237428952199424.