

Utilizing Online Databases as a 21st Century Learning Tool for Research Advancement

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ABSTRACT

The exploration of online databases and its implementation measures have become a hotspot in current research. What role will online database management play in the 21st century as well as in the next generation of the Web? We believe that the rate at which technological innovations is taking place in the information technology field will in a greater extent affect the number of trends signal, the ideas and techniques that will stir the next generation of online database. Consequently, the goal of most institutions and companies concerning online projects is to build an infrastructure for delivery of courses via the World Wide Web. This is aimed at delivering of research content, assessment of student competency in support of courses and researches across their various curricula and beyond, thereby providing an asynchronous, student-centered approach to research advancement. This research provides and discusses overview of online databases system and its features in order to address many of the new demands made by online data management. The methodology used was survey method, where we examined several journals, books, conference proceedings, websites and other materials that were relevant to our study on online databases. The results of various literature reviews were used to analyze the use of web-based database as a 21st century learning model/tool. We looked at twenty-three online databases in general but later scaled it down to eight where some features such as citation analysis, access options, developer etc. were looked at. Each online database has its own peculiarity that is of help to researchers in different disciplines. Thus, researchers would be relaying and paying more attention to online databases as a research hotspots in their various fields of endeavors. The practical implications of the study revealed that online databases will be versatile in the future and will be instrumental in advancing research field as well as being core instrument in supporting new knowledge insights. The study recommends, among others, the need to strengthen multidisciplinary databases cross-integration in different universities and institutions to push forward the boundary of knowledge.

Keywords: Database Management System (DBMS), DBMS Architecture, Research, Online database, DOI.

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1. Introduction

The development of research in the 21st century has been marked by progress and demands, namely the use of technological innovations. The 21st century has replaced human resources with technological sophistication and innovations leading to globalization, thus everything has become easier and more practical. The increasing amount of data from online systems is becoming one of the most valuable resources for information retrieval and knowledge discovery [1]. We are in a big data era and as a result data is everywhere including in the web. Databases have come to stay and therefore majority of the websites rely on some kind of database to organize and present data to users. Whenever someone uses the search engines or functions on these sites, their search terms are converted into queries for a database server to process and return a value which is an answer to the search. Typically, middleware connects the web server with the database to facilitate the search. The broad presence of databases in the Internet allows them to be used in almost any field for various purposes to satisfy the user quest, from online shopping to micro-targeting a voter segment as part of a political campaign to research advancement in knowledge acquisition. Various industries have developed their own norms for database design, from air transport to vehicle manufacturing as well as hotel booking and reservation.

In [2], the researchers illustrated how the authors selected the regional economics and carbon emissions related literature collected in the Web of Science (WOS) database as the basis for their research advancement, in addition the authors also make use of the bibliometric software Citespace and VOSviewer to visually analyze the time distribution, organization, author and keywords in their research field interest. With the availability of Online or online databases information relating to authors, institutions, countries and keywords can easily be analyzed and detected hotspots in the research field can easily be identified for proper actions ([3], [4]). Research collaboration among the researchers has come to stay, more future collaborations among various institutions in different countries are expected and thus advancing the frontier of research and knowledge. [5] argued that JSONiq is a viable and seamless programming language for data lake-houses across all their features, whether database-related or machine-learning-related. The aim of this study is to explore the ways in which online databases can be improved to better meet the needs of researchers. While the objectives are (i) to identify the role of online databases in supporting new knowledge and insights and (ii) to develop recommendations for improving the usability and accessibility of online databases as a means of research advancement.

1.1 The Web as a Delivery Channel and User-Generated Content

The Web has become a powerful and ubiquitous means of delivering a range of end-user applications (e.g., email, Whatsapp, telegram), collaborative applications (e.g., IM, Y! Answers), and enterprise applications (e.g., Salesforce.com) to hundreds of millions of users. According to [6] as online application development moves in the direction of online APIs, the requirements on the backend change substantially. This is because of the wide range of capabilities that may be combined into an application. Resulting in the creation of a radically different approach to developing and distributing applications, thus disrupting the traditional software distribution model. In turn, it has led to the development of new types of service-oriented software platforms, new kinds of customizable application environments as well as a massively distributed systems with novel quality of service guarantees, and the ability to manage massive numbers of application instances.

Online communities are a fundamental and increasingly important part of the Web and users' electronic life as can be seen in bulletin boards and real-time chat in various applications, in tagging, rating and reputation systems, and other such capabilities. Hosted application providers have such capabilities with potential advantages such as single and double authentication as the case may demand, integrated payment systems, and shared personalization are also on the increase. As knowledge acquisition increases, user-contributed content is becoming a key resource leading to a large and growing set of schemas meant to incorporate specifics of data type such as question/answer pairs, new articles, blog posts, Web pages, etc. As a variant of user-contributed content, [6] sees user-contributed metadata in the form of reviews, tags, bookmarks, ratings, or even clicks. These user-contributed contents can be used to carry our analysis that will help push the boundary of knowledge. As stated in [2] & [7] researches on the relevant distribution of literature by journals can provide scientific researchers with guidance on the timely screening of key information and the selection of a platform for publishing scientific research results after knowledge discovery.

[8] emphasized the fact that a technology-based teaching and learning offers various interesting ways which includes the usage of online databases, educational videos, stimulation, storage of data, mind-mapping, guided discovery, brainstorming, music, World Wide Web (www) that will make the learning process more fulfilling and meaningful. [9] pointed out that access to quality education is still a major bottleneck in developing countries and a lot of efforts are being made in opening the access to a large majority of citizens by means of multimedia technology. While [10] iterated that students viewed the internet as an online database of general information, which helped improve their reading behaviors and school success. In another study, [11] demonstrated that most students perceived that the lack of digital readiness among their staff (researchers) and institution,

the absence of electronic library for easy accessibility to journals from the scientific database as well as inefficient cybercafé and internet facility within their university settings were the main issues discouraging the utilization of the internet within their institutions. Furthermore, it was observed that some of the students perceived that they came across substantial and relevant scientific papers online but could not gain access to them, due to lack of subscription (which cost from \$15 upward) to scientific online databases by their institutions. This often restrict their access to scientific journals, as well as affected the quality of research output. [12] provided a synthesis of the literature on recent trends in new technologies and its effect on 21st century children (primary school or younger and 0-18 years old) in terms of economic, social and cultural status which underlie these trends and lead to online and offline inequalities. Thus, the need to build digital resilience is an important skill for 21st century children as well as the effects of new emerging technologies would be helpful for future research. In 2006, Emerald Insights predicted the accessibility of large databases via digital research libraries [13]. As of 2023, there has been significant growth in the number of digital libraries and their evolving offerings. Consequently, the followings are the significance of our study:

- i. This study will help to make research more efficient and productive by providing researchers with easy access to the information they need.
- ii. This study will help to close the gap between researchers and the information they need, which will lead to new discoveries and advancements in a variety of fields.
- iii. This study will provide a roadmap for libraries and other institutions to improve their online databases and make them more user-friendly and accessible.
- iv. This study will help to promote digital literacy and encourage the use of online databases among researchers.

The paper is organized as follows: *Section 1* introduces online databases in different fields where they were being used for research development. *Section 2* reviews DBMS architecture as the design of a DBMS depends on its architecture. We pointed out that the architecture of a DBMS can be visualized as either a single tier or a multi-tier. In *Section 3*, the results of various literature reviews were used to analyze the use of web based database as a 21st century learning model/tool for academic research advancement. *Section 4* deliberates on the role of online databases in advancing research, supporting new knowledge and Insights as well as guidance on effective utilization of online databases with the digital object identifier (DOI) system use for identifying content objects in the online database environment. In *Section 5*, we present how the online databases will serve as a research tool in the 21st century. Finally, *Section 6* concludes the paper with some recommendations which points out several possible future research directions.

2.0 Database Management System (DBMS) - Architecture

The design of a DBMS depends on its architecture. It can be centralized or decentralized or hierarchical. The architecture of a DBMS can be seen as either single tier or multi-tier. An n -tier architecture divides the whole system into related but independent n modules, which can be independently modified, altered, changed, or replaced.

When $n = 1$, we have the 1-tier Architecture or the single-tier architecture, such a DBMS is the only entity where the user directly sits on the DBMS and uses it. Any changes effected will directly be done on the DBMS itself. The 1-tier architecture does not provide handy tools for end-users, nevertheless database designers and programmers normally prefer to use it.

When $n = 2$, we have the 2-tier Architecture, in the 2-tier architecture, the DBMS must have an application through which the DBMS can be accessed. Programmers use 2-tier architecture where they can access the DBMS by means of an application. In the 2-tier architecture, the application tier is entirely independent of the database in terms of operation, design as well as programming.

When $n = 3$, we have the 3-tier Architecture, a 3-tier architecture separates its tiers from each other based on the complexity of the users and how they use the data present in the database. It is the most widely used architecture to design a DBMS. It should be noted that multiple-tier database architecture is highly modifiable, as almost all its components are independent and can be changed independently.

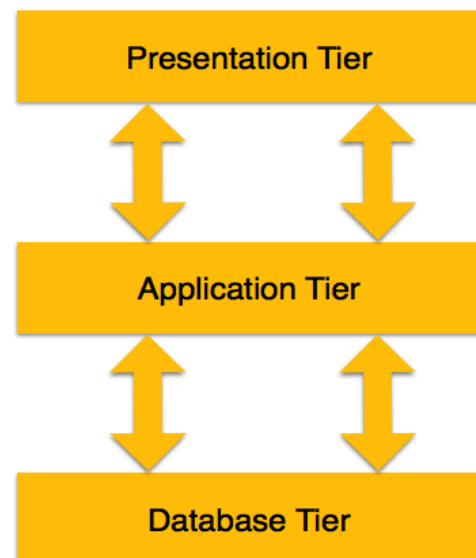


Figure 1: Database N-Tier Architecture [14]

- a. **Presentation Tier:** End-users operate on this tier and they know nothing about any existence of the

database beyond this layer. At this layer, multiple views of the database can be provided by the application and all views are generated by applications that reside in the application tier (see Figure 1).

- b. **Application Tier:** The application server and the programs that access the database are residual at this level. For a user, this application tier presents an abstracted view of the database. End-users are ignorant of any existence of the database beyond the application. At the other end, the database tier is also not aware of any other user beyond the application tier. Hence, the application layer sits in the middle and acts as a mediator between the end-user and the database. Consequently, it is also called the middleware tier.
- c. **Database Tier:** Lastly, at database tier, the database resides along with its query processing languages. The relations that define the data and their constraints are at this level.

2.1 Literature review

In [13] the authors discussed the requirements for the digital libraries of the future. He introduced as well as presented DILIGENT infrastructure as a technological response to these requirements. The roles of the digital libraries in the organizational framework was envisioned by DILIGENT infrastructure. He predicted that the digital libraries of the future will definitely give access to a large variety of multimedia and multi-type documents created by integrating content from many different heterogeneous sources such as repositories of text, images, audio-video, scientific data archives, and databases. This can be attested today in the various online databases that constitute part of the rich resources in the Internet, this is now a core instruments for serving a large class of applications, especially in the research field.

Online learning has come to stay as increasingly great number of students are moving to learn flexibly and independently through digital platforms especially using the Massive Open Online Courses in Learning Management Systems. [15] explored research trends relating to the use of Massive Open Online Courses (MOOCs) in Learning Management Systems (LMS) in university environments. Their results demonstrate the fact the use of MOOCs in LMS in the context of university learning has become an increasingly popular research topic in recent years, which has resulted in a significantly increase in the publication rate. While [16] investigated the research utilization behaviors of occupational therapists and also examined the differences in behaviors between those who had and had not used the NavigatorVR. The NavigatorVR is a virtual reality environment created by NASA that allows users

to explore various locations in space. Moreover, the NavigatorVR online competence assessment platform also supports research utilization through recommended readings and access to online databases with full-text articles. Their results showed an overall low level of research utilization, nevertheless, the NavigatorVR users are more likely to use online databases than non-users.

Online bibliographic databases are imperative tools for both literature research and clinical practices as they provide current scientific insight for evidence-based medicine. Furthermore, they have the ability to support clinicians by providing them with the information they need in a timely fashion. In a related study, [17] focused on online bibliographic database in the health sector to assess the utilization of online bibliographic databases by 153 medical doctors at the University Teaching Hospital of Kigali. Their results indicated the fact that most medical doctors (94%, N=82) visited online bibliographic database, 92% (N=82) of them have computers with internet in their offices, 97.6 % (N=80) have used online bibliographic databases in the past six months while 96% (N=80) were satisfied with their expectations. [18] investigated the utilization of web information resources (such as e-books, online journals, databases, and bibliographic databases) among scientists in Rubber Research Institute of India, Kottayam as such resources play a key role in both educational and professional settings. The results of their research revealed that the majority of the scientists indicated e-journals as the most used web information resource while few number of scientists made use the Web OPAC, institutional repositories as well as e-newspaper.

In a study that investigated the pattern of electronic database utilization by 16,902 undergraduates in study centers of National Open University of Nigerian (NOUN), [19] observed that majority of the undergraduates use electronic databases such as African Journals Online (AJOL), AGORA, HINARI, Science Direct, EBSCOHOST and Taylor and France in their research, class assignments, seminar/oral class presentations, update knowledge acquisition as well as keep abreast with the latest development. Nevertheless, the research also pointed out some of the challenges faced by majority of them which include slow internet service, shortage of power supply, lack of access to full text of citation and abstracts, lack of time for searching and lack of information literacy skills. Consequently, recommendations were made which among other things include constant subscription of electronic databases and use of an alternative power supply. A study that examined the role of access to online databases among 339 faculty members as the basis for faculty research output in six universities (comprising two each of federal, state and private) in two Southwestern states in Nigeria was carried out by [20]. The findings of the study revealed that HINARI, ProQuest, JSTOR, and EBSCOhost were the most regularly accessible online databases. Similar to the findings in [19], incessant

power supply and lack of downloadable full-text posed the greatest threats to online databases access. The study recommended adequate funding of university libraries, provision of alternative means of power generation as well as increased user education for maximum exploitation of subscribed databases as was also pointed out by previous researchers.

In [21] data was extracted during the period of 2000-2018 from Web of Science database for analysis and so a total of 2561 documents based on plagiarism were found and calculated. Furthermore, most of the documents on plagiarism were published in the year 2017 from their findings and the year 2017 was also regarded as the most productive year with huge number of publications. In their research work they also discover that 32 of the publications were published by anonymous authors while majority of the authors (59.74 %) were interested in publishing their writings in the form of articles. They were able to achieve this thanks to Web of Science database. [22] developed PROTAC-DB database, a web-based open-access database that integrates structural information such as their chemical structures, biological activities, physicochemical properties and experimental data of PROTACs. The PROTAC-DB database was equipped with a user-friendly web interface. PROTAC-DB was built using the Python web framework and deployed on a Linux server. All the data was stored in PostgreSQL (an object-relational database). Thus, the user-friendly PROTAC-DB server enables researchers to easily query, browse and analyze the structures of PROTACs in the database.

3. Methodology

We examined several journals, books, conference proceedings, websites and other materials that were relevant to our discussion on web-based databases and its importance to information systems [23] (Paperpile.com, 2023). The results of various literature reviews were used to analyze the use of web based database as a 21st century learning model/tool for (database) academic research advancement in the research institutes as well as in the educational sectors. A summary of database comparisons focusing on 23 research databases was carried out (see Table 1). It intentionally emphasizes on the year the database was established, focus (i.e. area of specialization), and resource type.

Furthermore, we analyze eight (8) research databases mainly: Scopus, WOS, PubMed, ERIC, IEEE Xplore, ScienceDirect, DOAJ and JSTOR, looking at some chosen characteristics and how they are related to these eight databases. The result of our analysis can be seen in Tables 2 and 3. Figures 2 (a) – 2 (h) display each of the interface of the eight selected databases.

Table 1: Summary of Database Comparisons

S/	Name of	Year	Focus	Resource
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N	Database	Established		Type
1	ABI/INFORM Collection	1971	Economic conditions, product information, Management Techniques	Articles, excerpts
2	Academic Search Complete	2007	Multidiscipline	Book excerpts, peer reviewed journal, newspaper, magazine
3	Bielefeld Academic Search Engine (BASE)	2004	Multidiscipline	Documents, articles
4	BioMed Central	1999	Biology, Medicine	Journals
5	Business Source Complete (BSC)	Not yet Identified	Economics, finance, business management, marketing and business law.	journals and magazines
6	CINAHL Complete	1977	Nurses and allied health professionals	Articles
7	Communication and Mass Media Complete (CMMC)	1965	Communication, logic, film/video, media studies, linguistics, discourse and rhetoric	journals and magazines
8	CORE	2005	Various Topics	journals, articles, essays
9	Directory of Open Access Journals (DOAJ)	2003	technology, medicine, social sciences, arts, humanities and all areas of science	Journals
10	Dryad	2008	Medicine and science	Tables, spreadsheet, flat files and articles.
11	EBSCO	1984	Applied	Peer-

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			science, humanities, sociology and business.	reviewed articles	2		2b	2c	2d
12	EconBiz	2007	economics and business	Journals and conferences	Coverage	approx. 82.4 million items	approx. 100 million items	approx. 35 million items	approx. 1.5 million items
13	Education Resources Information Center (ERIC)	1966	Academic Field	Education based literature	Period covered	1966-present	1900-present	1950-present	1966-present
14	Institute of Electrical and Electronics Engineers (IEEE) Xplore	1988	Engineering and computer science	Journals, conference papers, essays, books and articles	Interdisciplinary field coverage	Strength	Strength	Weakness	Weakness
15	Journal Storage (JSTOR)	1994	Multidiscipline	Essays, images, books. and articles	Updated	Daily	Daily	Daily	Monthly
16	JURN	2009	Arts and humanities.	Journals	Citation analysis	Yes	Yes	None	Yes
17	Paperity	2014	Multidiscipline	Documents and articles	Access options	Limited free preview, full access by institutional subscription only	institutional subscription only	Free	Free
18	PsycINFO	1967	Psychology and sociology	Articles	Developer	Elsevier	Clarivate Analytics (formerly Thomson Reuters)	NIH	U.S. Department of Education
19	Public Library of Science (PLOS)	2000	Science and Medicine	Articles	Strengths	- Visually stunning author and citation reports. - Includes Altmetrics when available (on abstract page). - Includes in-press articles.	- Covers only “journals of influence” - Coverage back to 1900. - Publish Neutral.	- It uses various tools to get the most relevant results. - It is more precise for finding valid studies.	- It has a variety of search engines to choose from.
20	PubMed	1996	Medical and Biology	Articles	Weaknesses	-Early reports pointed out weak in social sciences and humanities -Studies show still weak in sociology and physics/astromy	- Difficultly searching unusual author name formats: hyphenated, compou	- Its interface can be daunting. - It is sometimes unclear how a search	- It can be difficult to obtain usage statistics.
21	ScienceDirect	1997	Multidisciplinary	journals and e-books					
22	Scopus	2004	Multidisciplinary	Articles					
23	Web of Science (WOS)	1997	Science, social science and humanities	Articles and essays					

Table 2: Detailed Comparison of Some Popular Academic Research Database – Part 1

Features	Scopus	WOS	PubMed	ERIC
See Figure	Figure 2a	Figure	Figure	Figure

- Typographical errors in records	nd names, umlauts, etc. - Punctuation issues - e.g., ampersands in journal titles.	has worked - It does not necessarily contain links to full-text.
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	of global technologies. - It drives functionality, capabilities, safety and interoperability of products.	researchers move seamlessly among books, topics and disciplines. - Users can work more effectively and efficiently.	Interdisciplinary research - Potential for more citations	- Create new tools and functionality every year. - Continuous expansion of diversity of content.
Weaknesses	- It contains unauthorized use. - Network security is at risk. - Periodic maintenance is required.	- Articles saved on a mobile device cannot be accessed from a user's ScienceDirect account.	- Expensive for researchers. - Dwindling quality concerns. - Diminished trust.	- It includes journals that want an embargo period on their contents. - It searches the full text of every article.

Table 3: Detailed Comparison of Some Popular Academic Research Database – Part 2

Features	IEEE Xplore	Science Direct	DOAJ	JSTOR
See Figure 2	Figure 2e	Figure 2f	Figure 2g	Figure 2h
Coverage	approx. 5 million items	approx. 16 million items	approx. 4.3 million items	approx. 12 million items
Period covered	1872-present	1995-present	Unknown	1665-present
Interdisciplinary field coverage	Weakness	Strength	Strength	Strength
Updated Frequency	Daily	Daily	Daily	Daily
Citation analysis	Yes	Yes	Yes	No
Access options	Limited free preview, full access by institutional subscription only	institutional subscription only	Free	Free
Developer	IEEE Xplore	Elsevier	DOAJ	ITHAKA
Strengths	- It nurtures, develops, and advances the building	- It supports an uninterrupted workflow so	- Transparency - Availability	- Interdisciplinary focus. - Consistent access.

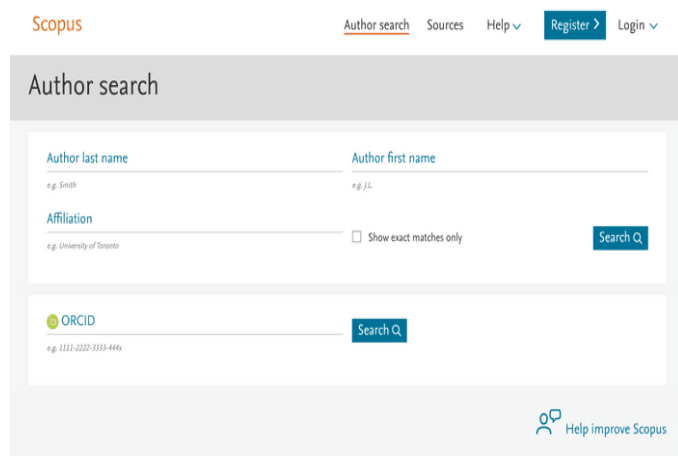


Figure 2(a): Scopus Interface

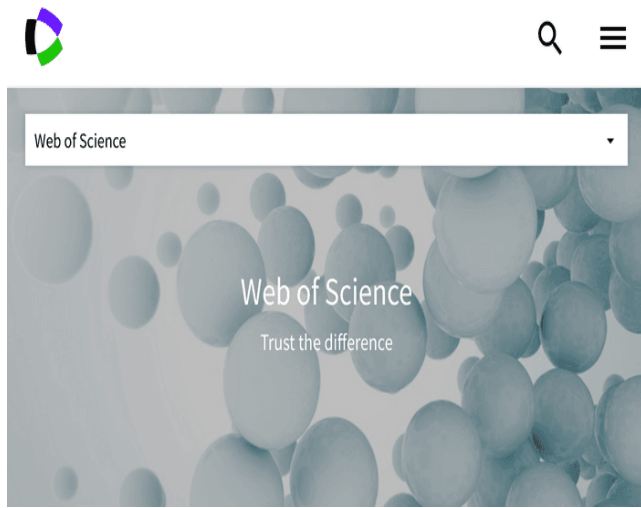


Figure 2(b): Web of Science Interface



Figure 2(d): ERIC Interface

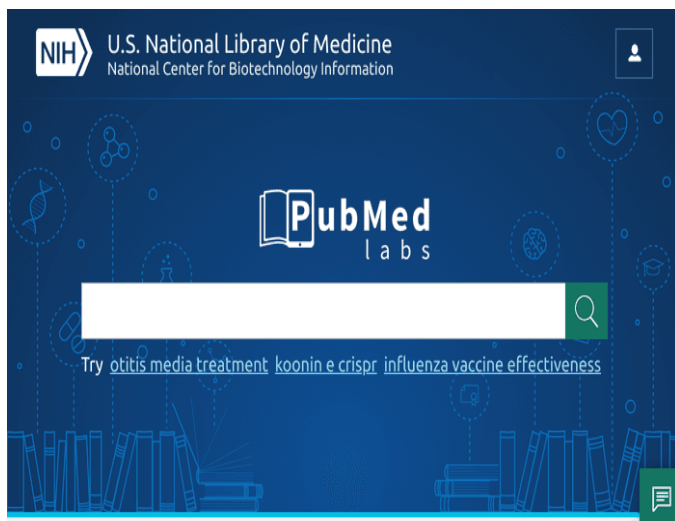


Figure 2(c): PubMed Interface

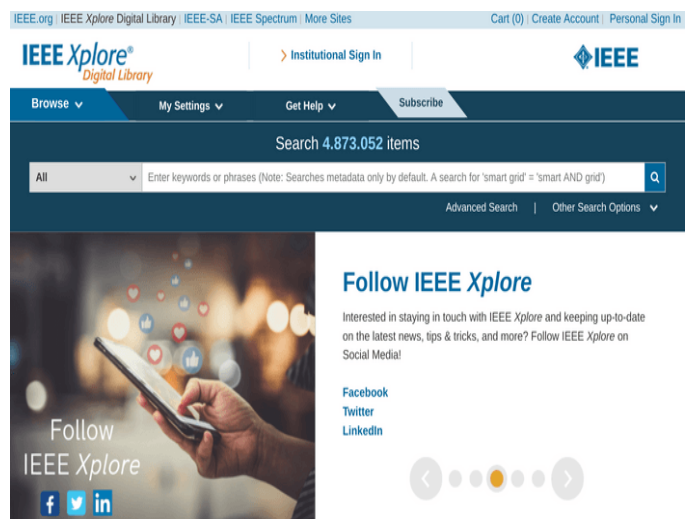
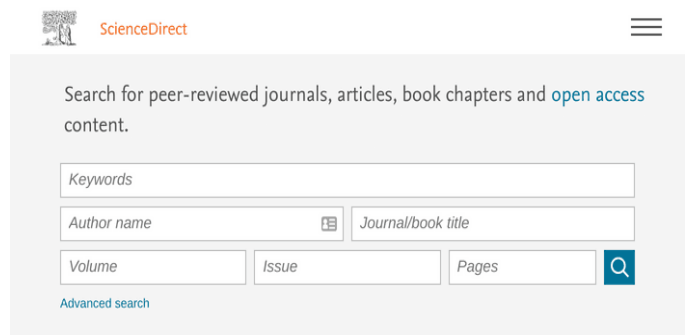
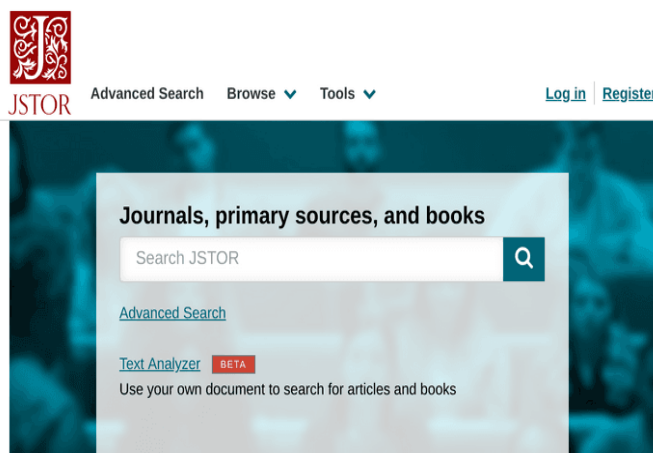


Figure 2(e): IEEE Xplore Interface



Explore scientific, technical, and medical research on ScienceDirect

Figure 2(f): ScienceDirect Interface**Figure 2(g): DOAJ Interface****Figure 2(h): JSTOR Interface**

Note: Figures 2(a) to 2(h) are the website interfaces of the specified academic databases.

4. Findings/Results/Discussion

4.0 The Role of Online Databases in Advancing Research

It is obvious that online databases are an essential part of the research process, and it is important to understand their role and importance.

- i. Online databases play a crucial role in advancing research by providing researchers with access to a wealth of information and resources.
- ii. They allow researchers to search for and find

relevant sources quickly and easily, and to stay up-to-date on the latest research in their field.

- iii. They also provide a way for researchers to share their work with a wider audience, and to collaborate with other researchers around the world.
- iv. Online databases can be a powerful tool for advancing research and making new discoveries.

4.1 The Role of online Databases in Supporting New Knowledge and Insights

- i. The availability of various online databases enable researchers to perform literature search and reviews in a more conducive way.
- ii. The enormous online databases in various disciplines create an unlimited research opportunities, outcomes, and innovating ideas that expand the frontiers of knowledge.
- iii. As no single database can search all the literature of a particular discipline, the choice of database depends uniquely on the subject of interest as well as potential coverage by the different databases. Thus complimentary one another.
- iv. The emergency and growth of accessible online databases will provide opportunities in widely disparate disciplines.
- v. Accessible online databases have become essential component of the research facilities and infrastructure which is comparable to laboratories.
- vi. With the help of electronic technologies, an accessible online database has created pathways through which researchers can communicate data and results to others.
- vii. Apart from containing researchers' manuscripts, many online databases also contain researchers' post, simulations, software packages, oral and postal presentations as well as other scholarly products which act as a catalyst for skills and knowledge acquisition.
- viii. The expansion in digital frontier create the potential of online databases to cater for the needs of the scholar, researchers as well as students.

4.2 Guidance on Effective Utilization of Online Databases

To effectively utilize online databases, it is important to understand the strengths and limitations of each online database, as well as the specific search features and filters available. The followings should be considered for an effect utilization of online databases:

(a) Craft Effective Search Queries: One key aspect of effectively utilizing online databases is learning how to craft effective search queries. The best search queries are usually fairly specific and use a combination of keywords and search operators, such as "AND," "OR," and "NOT." By using search operators, you can narrow down your results and find the most relevant sources.

(b) Use Advanced Search Features during Research: There are a number of advanced search features that can be useful when conducting research in online databases. One feature that is often available is the ability to search within a specific field, such as the title, abstract, or author. This can help you to narrow down your results and find the most relevant articles. Secondly, advanced feature that can be useful is the ability to export your search results into a citation management tool, such as Mendeley or Zotero. This can help in keeping track of the sources and create citations and bibliographies more easily. Thirdly, useful feature is the ability to save searches and set up email alerts. This can help you to stay up to date on new articles that match your search criteria.

(c) Citation Management Tool: Citation management tools can be helpful, but they are not essential for effective research. As long as a user keeps track of his/her sources and follow the appropriate citation style in a chosen field, users can still create high-quality citations and bibliographies.

(d) Free and Paid Online Databases: Additionally, it is important to consider the level of access users have to the database: paid databases through ones institution, or limited free databases. Having access to both free and paid databases gives user a wide range of options to explore. For paid databases, it is important to make the most of the access available. Many paid databases offer advanced search features, such as the ability to search by author, publication date, or specific keywords.

4.3 The Digital Object Identifier (DOI) System and Academic Research Database

The digital object identifier (DOI) system is for identifying content objects in the digital environment. Thus, it is like a social security number for a document online. DOI names are assigned to any entity for use on digital networks. DOI is a unique and permanent identifier that will take you straight to a document no matter where it is located on the Internet. This is crucial in the 21st century since the rate at which data are being generated and produced is on the increase and we are living in a big data era. Without the DOIs, if you locate a data today on the Internet and comes the next day you will only discover that the data have disappeared in the thin air. They are used to provide current information, including where they (or information about them) can be found on the Internet. Information about a digital object may change over time,

including where to find it, but its DOI name will not change. Furthermore, they are used to provide a framework for persistent identification, managing intellectual content, managing metadata, linking customers with content suppliers, facilitating electronic commerce, and enabling automated management of media. DOI names can be used in or for any form of management of any data, whether commercial or non-commercial [24]. A database that is equipped with a DOI will help potential researchers and readers to easily locate a document from a citation. Currently, DOI is not being used in popular magazines and newspapers, we however believe that DOIs will soon be used in popular magazines and newspapers. Academic journals articles, books, conference proceedings and academic magazines have already started adopting it. For examples:

- a) Tan, L., Guo, J., Mohanarajah, S., Zhou, K., 2021. Can we detect trends in natural disaster management with artificial intelligence? A review of modelling practices. *Nat. Hazards* 107, 2389–2417. <https://doi.org/10.1007/s11069-020-04429-3>.
- b) Fang, H., 2015. Managing data lakes in big data era: what's a data lake and why has it become popular in data management ecosystem. 2015 IEEE International Conference on Cyber Technology in Automation, Control, and Intelligent Systems (CYBER). IEEE, pp. 820–824. <https://doi.org/10.1109/CYBER.2015.7288049>.

All DOIs start with the number 10 followed by a period. If a researcher cannot find the DOI in an article, he can simply search on the www.crossref.org using information like the author, the article title as well as the journal name. Crossref assign DOIs to scholarly research publications. In the 21st century some databases will be open to adding new definitions as well as data to it, thus creating a dynamic setup in a database that allows for the addition of more expert opinions as well as new discoveries and findings in the field of studies.

5.0 How the Online Database will serve as a Research Tool in the 21st Century

- a. With the help of online databases, increase access to sensitive issues as well as vulnerable/hidden populations can be achieved seamlessly.
- b. Online database research is much more impactful than the traditional research as the ease of access to information is high while saving cost associated with it low.
- c. Repositioning of the academic library, as a result of the online databases, librarians in various institutions are forced to reposition the academic library for effective service delivery in supporting teaching, learning and research.
- d. Hybrid libraries are acting as a panacea for meeting the information needs of 21st century library users who exhibit much dexterity in using new trend in technology innovations.

- e. The digital object identifier system will be exploited by many institutions in digitizing projects, theses and dissertations for quick search and accessibility.
- f. Research papers done by students or lecturers in various university libraries will be upload publicly in the online database system, which will promote excellent research and academic activities.
- g. Online research databases is very significant aspect of modern technology as they will enhance learning and research outputs when introduced by authorities in charge of higher education.
- h. Students and researchers will be encouraged to navigate their own way through online research databases which will enhance their research quality via various databases for deep learning and information management.
- i. Many universities will start offering courses and workshops focusing on online research databases, this will cause the library authorities to pay more attention to the evaluation of students' technological abilities and skills in using online databases.
- j. Using online databases, Universities will be positioned to compare research findings around a particular subject matter which will further encourage virtual interactions for sharing research findings as well as share experiences.

6.0 Conclusion and Recommendations

6.1 Conclusion

We looked at twenty-three online databases in general but later scaled it down to eight where some characteristics such as citation analysis, access options, developer etc. were looked at. Each online database has its own peculiarity that is of help to researchers in different disciplines. This research is helpful to understand online database characteristics and key driving forces, thus providing appropriate policy recommendations for future software developers who specializes in database. To create awareness and share experiences with researchers worldwide should have open access to some databases. Industry and academia must work in collaboration with each other to enhance the application of user-friendly online database technologies for research breakthrough. Institutions and scholars, both in developing countries and developed countries, are concerned and interested in online databases that will boost their research productivity and rich research results. Scholars are to be encouraged to collaborate in the further development of the online database as well as to make use of its various possibilities in their own research projects. From the perspective of a research, this research expounds on the impact of online databases and gives recommendations. In the future, it is necessary to increase online databases research investment at the specific level of innovations. The following are potential future research areas related to using online databases as a 21st century learning tool for research advancement:

- i. The impact of online databases on the research process.
- ii. The effectiveness of online databases in facilitating information discovery and retrieval.
- iii. The role of online databases in supporting interdisciplinary research.
- iv. The ethical, legal, and social implications of using online databases in research.

6.2 Recommendations

- a. Databases should be continuously expandable and versioned (i.e. 1.0, 2.0, 3.0 etc.).
- b. Databases should be referral to DOI assigned to data which will help a potential researcher or reader easily locate a document seamlessly.
- c. Interconnectedness with other databases should be promoted.
- d. The dynamic setup of some database should be encouraged to allow for the addition of more expert opinions as well as allow continuous data additions and editing.
- e. The database additions submitted should be regularly processed by the database administrators and then added to the database.
- f. Database security is very important, thus we recommend that database be hosted on an Oracle server behind a firewall.
- g. Future research should strengthen multidisciplinary databases cross-integration in different universities and institutions to push forward the boundary of knowledge.

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