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Retrieval efficiency of select search engines vis-à-vis diverse open courseware formats

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Abstract

Purpose – This paper aims to gauge the visibility of open content available in different formats of select open courseware (OCW) repositories through prominent search engines.

Design/methodology/approach – Open content in three formats (pdf, audio and video) from four OCW repositories listed in the OCW consortium under the science and technology subject heading were searched through seven select search engines.

Findings – None of the selected OCW repositories are fully visible on the selected search engines. Visibility of OCW content varied from one search engine to the other and was affected by the format in which it is available. Google is the best search engine for retrieving OCW content, whereas OCWfinder – a specialized search engine for retrieving OCW – has performed dismally.

Research limitations/implications – The study demonstrates the need for enhancing the visibility of open content through using search engine optimization techniques.

Originality/value – The study intends to supply findings that could be used by stakeholders to improve the visibility of OCW repositories. It is an attempt to draw a comparison between search engines for their ability to index different formats of OCW in the selected repositories. Findings can be used by information professionals to brush their information hunting skills.

Keywords Search engines, Visibility, Open learning, Open courseware

Paper type Research paper

Introduction

Information communication technology (ICT) has transformed the field of education. The emergence of new technologies has reduced many barriers to provide education to those who were previously deprived of it. ICT is the bedrock of modern open and distance education, and supports the completion of objectives, such as the following (Bates, 1997, as cited in Shirley, 2001):

- to improve the quality of learning;
- to improve access to education and training;
- to reduce the cost of education; and
- to improve the cost effectiveness of education.

The Internet and the World Wide Web have made education more flexible. A person can now learn anytime they have time. They can listen to or speak to professors who are

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delivering lectures in foreign universities. The Internet has presented a bouquet of different learning tools which have revolutionized learning and teaching processes. With the advances in Web technologies over the past two decades, educational opportunities accessible through the Internet have expanded dramatically. These opportunities are offered on many platforms and have opened new doors for teaching and learning. A new form of lifelong learning has emerged called e-learning or online learning. Open courseware (OCW) is one of these revolutionary online learning tools. OCW is defined as a free and open digital publication of high-quality college- and university-level educational materials. These materials are organized as courses, and often include course planning materials and evaluation tools as well as thematic content. Open courses are free and openly licensed, accessible to anyone, anytime via the Internet (Open Courseware Consortium, 2012).

After the successful launch of the first OCW initiative by the Massachusetts Institute of Technology in 2001, a worldwide movement towards the development and sharing of OCW was initiated. This effort, called the OCW movement, has attained great heights in providing quality and flexible education worldwide. Authorities such as Brown and Adler (2008) described the OCW movement as the most visible impact of the Internet on education. Through the availability of courseware, institutes which have highly skilled teachers, multimedia educational resources and so forth, host their customized learning objects on the Web for free and make them available for worldwide access. OCW assists teaching and learning in many ways, such as:

- it provides a medium for students and lifelong learners to learn;
- it makes complex conceptual ideas understandable with the use of multimedia and simulations;
- it assists teachers in preparing for their lectures and demonstrations in a better way;
- it provides the opportunity for students and teachers to learn from world renowned authorities; and
- it facilitates review and collaboration in the design and implementation of learning objects.

However, hosting OCW in a repository is not sufficient to serve the purpose. The majority of users find it difficult to formulate their queries and, hence, have difficulty in locating information resources (Jansen and Pooch, 2001). Thus, most of the users are not able to locate their needed course materials and are not able to obtain full benefit from the course. To overcome such problems, OCW needs to be visible. Visibility can be defined as the extent to which a user is likely to come across a reference to a website in their online or offline environment (Drez and Zufreyden, 2011). OCW repositories should be visible through directories, search engines and other data discovery tools. The courseware that lies deep in such repositories should be visible through data discovery tools, such as search engines and directories, to help users in locating the courseware. Visibility increases the chances of an encounter between a user and their resource and is indispensable for accelerating overall traffic and credibility of a resource. High visibility increases the options of criticism and feedback from end-users who are actually the best evaluators of a resource. OCW helps colleges and universities attract students, scholars and teachers in online, as well as in offline, mode. Take the case of MIT, after they

launched their OCW repository, there was a 56 per cent increase in online traffic to their website. Similarly, 35 per cent of regular students based their choice of enrolling at MIT after their exposure to its OCW repository (Bossu and Tynan, 2011).

Problem statement

OCW is a promising mode of learning. These are available in multiple formats to suit the requirements of a variety of learners. Every learner has their choice of selecting courseware; one may go for a video or an audio, while another can ask for a PDF version. Against this backdrop, the present study explores selected OCW repositories with multimedia content and gauges the visibility of their courseware in varied formats through select search engines.

Literature review

After a review of related literature, it was found that very little research has been done on open educational resources (OERs). Studies directly pertaining to the topic are few and far between because of its novelty. However, an ample body of literature is available regarding "search engine efficiency and visibility of diverse online resources", which both are inherent themes of the paper and are examined below.

Measurements

Studies focused on the retrieval of different search terms using search engines started in the mid-1990s. In 1996, Chu and Rosenthal (1996) conducted a study of ten search results using ten queries drawn from real reference questions and three search engines (Alta-Vista, Lycos and Excite). In the same year, Ding and Marchionimi (1996) analysed 20 results from three English search engines using five queries. Clarke and Willett (1997) compared the retrieval efficiency of Alta-Vista, Excite and Lycos. In addition, they critically evaluated earlier research and provided a realistic methodology, including relative recall measures. It was found that Alta-Vista performed significantly better than Lycos and Excite. Similarly, the first 20 results received from the eight selected search engines were examined against 33 business-related queries by Gordon and Pathak (1999). In the same year, Leighton and Srivastava (1999) used five search engines – namely, Alta-Vista, Excite, HotBot, Infoseek and Lycos – to compare precision on the first 20 results returned for 15 queries.

In a similar attempt, Griesbaum (2004) investigated the retrieval effectiveness of three German Web search services (Alta-Vista.de, Google.de and Lycos.de), with 50 queries, using the top 50 links. One independent evaluator judged two link sets and made relevance assessments. Statistical analysis showed that Google performed significantly better than Alta-Vista, but there was no significant difference between Google and Lycos. Likewise, using 12 queries, Wu and Li (2004) evaluated the effectiveness of four search engines (Google, AllTheWeb, Hotbot and Alta-Vista) and four meta-search engines (MetaCrawler, ProFusion, MetaFind and Meta-EUREKA). Experimental results showed that, on average, the performances of the selected meta-search engines and the search engines were very close, although there were no statistical tests evaluating search engine differences performed. In the same year, Vaughan (2004) used three search engines (Google, Alta-Vista and Teoma), four queries and the first ten links from each search engine. The researcher used 24 evaluators to rate the links. The researcher examined the quality of ranking compared to human evaluations, the ability to retrieve top ranked pages and stability. Google performed best

in the rankings, in the ability to retrieve top ranked pages and in stability over a ten week period. Akin to this study, Shafi and Rather (2005) executed a study on five search engines (Alta-Vista, Google, HotBot, Scirus and Bioweb) and biotechnology-related terms in which they evaluated the first ten results pertaining to scholarly information for the calculation of precision, as well as recall, and found that the Scirus search engine retrieved more comprehensive results than Google and HotBot.

To examine the stability of result rankings, Veronis (2006) conducted a study on the basis of 70 French language search terms and the first ten results on six selected search engines. Yi and Jin (2007) conducted a hyperlink analysis of several Canadian library and information science websites. They used the AlltheWeb search engine to observe the in-links pointing to library and information science school websites. Four content clusters were identified to group the content of the school Web pages: library information sciences, research, homepage and resources. The most visible topics were student activities/projects, library/information science-related resources and course-related information. Using a different approach, Kumar and Prakash (2009) compared the retrieval effectiveness of two search engines by using 15 library and information science search terms and 100 results, and found that Google retrieved more precise results than Yahoo.

In another study, Erfanmanesh and Didegah (2010) used data from the Alexa Databank to rank Malaysian public university websites. Similarly, Akakandelwa (2011) conducted an exploratory survey of South African development community e-government websites. He used content analysis and in-link analysis to evaluate the sites. He observed a marked variation in the visibility and interactivity of the sites. Likewise, Lewandowski (2011) examined the quantity of relevant results yielded from three selected search engines, namely, Google, Microsoft and Yahoo.

Visibility studies

Even though there are a number of OER repositories located across the globe with disparate resources, their use has been slow because of the lack of accurate searching mechanisms (Abeywardena *et al.*, 2012). Likewise, Dicheva and Dichev (2014) observed that the poor findability of OERs in different repositories is one of the barriers to the large-scale uptake and use of OERs. They proposed a CS-OER portal as a one-stop solution for finding computer science OERs. Similarly, Vladoiu (2013) considered locating and retrieving of OCW to be the most relevant challenge to user needs, and compiled a comprehensive list of OCW repositories and search engines for overcoming the challenge. In a similar fashion, Piedra *et al.* (2014) developed Serendipity, a faceted search engine, to find and discover OERs related to OCW from the OpenCourseWare Consortium and OCW-Universia. Sowards (2004) counted visibility as an important factor for a Web resource for its selection as a ready reference Web resource in American libraries. Erfanmanesh and Didegah (2011) used Alta-Vista to study the visibility of Iranian research institutions and data from the Alexa Databank to rank Iranian websites. In a similar and earlier study, the same authors, Erfanmanesh and Didegah (2010), measured the visibility of Malaysian public university websites and used data from the Alexa Databank to rank them. Didegah and Goltaji (2010) conducted a detailed webometric analysis of Islamic universities through the use of the Alta-Vista search engine. Web impact factor and visibility were prominent factors that helped Malaysian universities rank at the top, whereas the University of Kazakhstan was last on the list.

Elgohary (2008) used Alta-Vista to find the visibility of Arab universities on the Web. He came to the conclusion that 40 per cent of Arab universities had a low Web presence. Likewise, Bowler *et al.* (2011) used Google's Web Master Tools to check the visibility of 16 health portals which were selected through an environmental scan and later subjected to link analysis. Bhat (2009) conducted a visibility test of five open access repositories through title searches in ten search engines. He concluded that visibility ranged from 5-92 per cent and noted that general search engines (Google, MSN, Yahoo and Ask.com) outperformed the subject specific search engines. OAISTER, despite being an open archives initiative protocol for metadata harvesting using OAIPMH (a complaint search engine), had unsatisfactory performance.

Reyneke *et al.* (2011) gauged the pattern of visibility of a luxury wine brand through the use of HowSociable.com. Web visibility of four electronic newspapers, one each from USA, Canada, China and Hong Kong, was gauged by Gao and Vaughan (2005). They used Yahoo for gathering in-links and found that the *Globe and Mail* was the most visible among the four. Russell *et al.* (2012) indicated generally poor visibility of research activities in institutional websites of the national autonomous University of Mexico on the basis of their study using Scopus, Web of Science, Clase and Periodica. Drez and Zufreyden (2011) provided a detailed discussion on the visibility of a website and factors which are responsible for the increased visibility. The authors analysed all of the major parameters, such as listings in directories, links from other websites, online searches, online advertising and so forth, which act as physical drivers of online visibility. They devised an Internet visibility index to provide comparisons between online shopping websites. Chu *et al.* (2002) used Fast (www.alltheweb.com) to get in-links and co-links to 53 American Library Association's accredited library and information science schools. The study aimed to gauge the visibility of the schools. They concluded that the current version of Fast is a reasonable substitute for Alta-Vista as a data collection tool.

It is clear from the published literature that much of the work has been done on search engine retrieval efficiency and that tools for gauging the visibility of portals, websites and repositories have been usyed. These earlier studies substantiate the methodology used in the present study and, hence, are appropriate tools to gauge the visibility of OCW.

Objectives

Following are the objectives of this study:

- to gauge format-wise the visibility of open courseware;
- to compare the visibility of selected OCW repositories *vis-à-vis* different formats; and
- to compare the search efficiency of selected search tools *vis-à-vis* OCW.

Scope

The scope of the study was confined to OCW repositories that contained a reasonable number of resources in the English language and were listed in the OCW Consortium under the science and technology subject heading. The scope was further restricted by the available formats of the courseware; only those repositories which contained resources in multiple formats of audio, video and PDF were selected.

Methodology

The present study was undertaken in two steps.

First step

OCW repositories under the heading of science and technology in the catalogue of the Open Courseware Consortium (available at: www.ocwconsortium.org/en/courses/catalog) were enumerated. In-depth exploration of the listed repositories was carried out to verify their compliance to the scope (in terms of language and format) of the study. It was found that 20 OCW repositories met the scope of the study. However, Novell possessed a dead link over several repeated attempts and People's Uni: People's Open Access Education Initiative required payment of fees for accessing it. These two repositories were excluded from the study. Thus, out of 20 repositories, 18 were selected for study.

Second step

Four (20 per cent) of 18 OCW repositories were selected by random sampling for visibility studies. These four repositories – Johns Hopkins Bloomberg School of Public Health (JHSP), Tufts Open Courseware (Tufts), New Jersey Institute of Technology (NJIT) and Open Michigan – were searched in-depth to ascertain the total number of courseware provided and format distribution. A suitable sample size of each format from each repository was selected for determining their visibility on the Web. Seven search engines were selected for the study. Out of the seven selected search engines, four (Google, Ask.com, Alta-Vista and HotBot) are general search engines. One (IncyWincy) is a deep Web search engine. Two search engines (Scirus and OCWfinder) are specialized search engines for science and OCW resources, respectively. Titles of PDF documents, videos and audios were taken as keywords. The selected documents from each repository were searched as a phrase in the selected search engines/data discovery tools in simple search mode. The items that could not be located as a phrase in simple search mode were searched using all possible search approaches available in advanced search mode. Each query submitted to the selected search engines retrieved a number of results, but only those results with the URL of that specific repository to which it belonged were taken into consideration for determining the visibility. Research has proved that an average of 80 per cent of users read just the first page of results retrieved by search engines and most search engines present ten hits on the first page (Silverstein *et al.*, 1999). Therefore, only the first ten retrieved results were taken into consideration.

The process of determining the visibility of the selected resources was started on 26 April 2012 and completed on 27 May 2012. The collected data were tabulated, presented and analysed in a systematic way to reveal the findings in accordance with the desired objectives.

Analysis and discussion

OCW repositories: an overview

OCW repositories show a great diversity in the number of courses they offer. The Student Circle Network provided the highest number of courses (10,431), while Weber State Open Courseware offered the least (7). Fewer than 100 different coursewares were offered by the majority (12) of the OCW repositories. Most of the OCW repositories are from the USA. Table I presents an overview of these findings.

Rank	Name of courseware site	No. of courses	Country
1	Student Circle Network	10,431	Cyprus
2	MIT Open Courseware	2,141	USA
3	The Open University	463	UK
4	Tokyo Tech Open Courseware	129	Japan
5	John Hopkins Bloomberg School of Public Health Open Courseware (JHSPH)	107	USA
6	Korea University Open Courseware	101	South Korea
7	Open Michigan	77	USA
8	Open Courseware University of California Irvine	64	USA
9	University of Notre Dame Open Courseware	64	USA
10	Tufts Open Courseware	50	USA
11	University of Nottingham Open Courseware	49	UK
12	Open Courseware Capilano University	23	Canada
13	New Jersey Institute of Technology (NJIT)	22	USA
14	United Nations University Open Courseware	16	Japan
15	IE University Open Courseware	10	Spain
16	Dixie State College of Utah	10	USA
17	Kaplan University Open Courseware Site	9	USA
18	Weber State Open Courseware	7	USA

Table I. Major OCW repositories in science and technology in terms of magnitude of courseware

Visibility by format

Portable document format (PDF) is the most popular format of information dissemination to date. It was found that the JHSPH OCW repository PDF resources are, on average, 74.5 per cent retrieved by search engines; hence, it is more effective than the others. Open Michigan ranks second (60.5 per cent), Tufts OCW third (60.0 per cent) and NJIT last (16.7 per cent). PDF courseware in the Tufts OCW had the highest level of retrievability by Google (90.0 per cent). Google is also more efficient at retrieving PDF files from Open Michigan (84.2 per cent) and JHSPH (80.0 per cent). PDF documents from NJIT are equally visible (16.7 per cent) across all general engines, except Ask.com which retrieved none of its documents. Google retrieved 97 out of 131 (74.1 per cent) PDF files and is, therefore, the search engine of choice for retrieving PDF courseware. It is notable that OCWfinder, IncyWincy and Ask.com retrieved none of the documents from NJIT. Detailed results are shown in Figure 1.

Visibility of video courseware

Regarding the visibility of videos, JHSPH and Open Michigan both had 100 per cent average visibility. Tufts OCW and NJIT follow with an average 50 per cent of their videos being retrievable by search engines. The overall retrieval percentage rate is 65.2 per cent. For JHSPH, the OCWfinder retrieved eight out of nine videos (88 per cent), which is its highest retrieval performance. It did not retrieve any of the videos from Open Michigan and NJIT. Ask.com and Hotbot retrieved the maximum (76.1 per cent) of videos. IncyWincy recalled zero videos, while Scirus, one of the leading science search engines, retrieved just 13.6 per cent for NJIT videos. Figure 2 offers a picture of these findings.

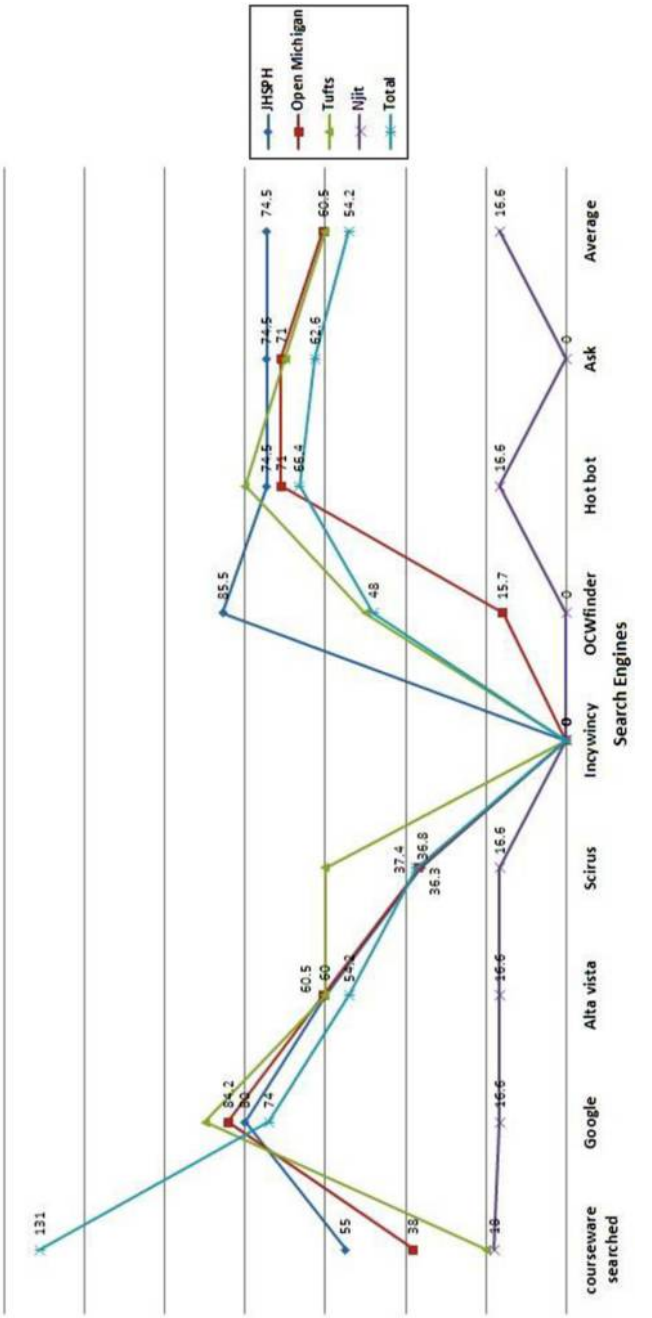

Figure 1.
Visibility of PDF resources by different search engines

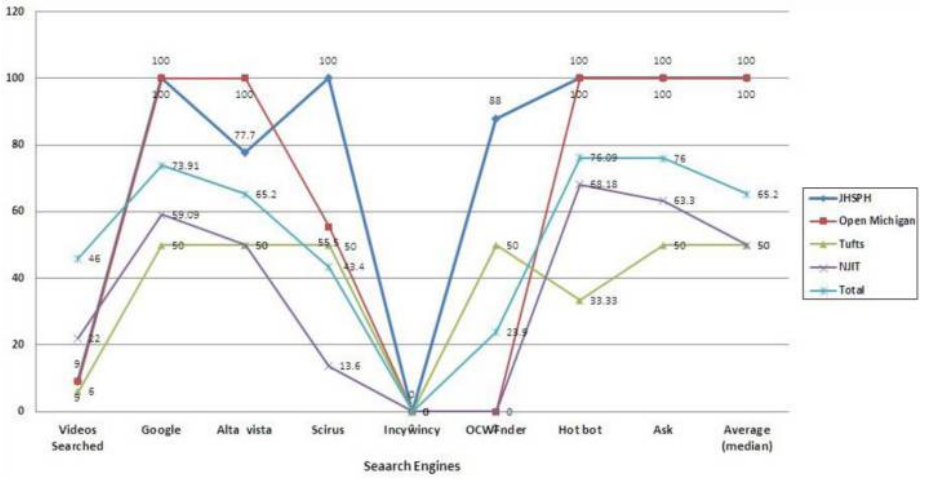

Figure 2.
Visibility of video resources by various search engines

Visibility of audio courseware

The study observed that the overall visibility of audio media is 44.9 per cent. Open Michigan audio resources were retrieved to the maximum (100 per cent) by all of the general search engines. JHSPH, which stands first in video visibility, slipped to third place for audio. It is evident that NJIT continues to be last in the list with an average visibility of only 18.8 per cent. OCWfinder retrieved none of the audio items from Open Michigan and NJIT and, as noted above, it did not retrieve any videos from these two repositories. Scirus retrieved 27 audio items out of 69 (39.1 per cent), which is its lowest performance in this study. Figure 3 summarizes these findings.

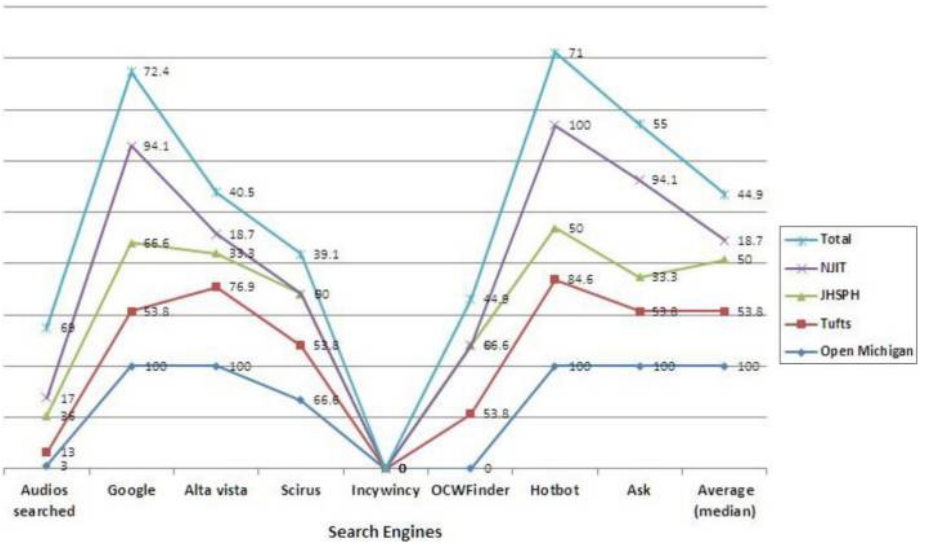

Figure 3.
Visibility of audio resources by various search engines

Comparison of search engines for retrieving different formats

It is evident from Figure 4 that the format of a resource affects its indexing and retrieval capabilities by search engines. Videos are the most retrievable among the three investigated formats with 65.2 per cent average visibility. PDF documents have 54.2 per cent and audio media have 44.9 per cent visibility through the selected search engines. The real competition for indexing OCW is between the general search engines (Google at 73.6 per cent, HotBot 69.5 per cent and Ask.com 63.1 per cent). Specialized search engines are lagging behind in indexing OCW. Alta-Vista (52.4 per cent) performed better than Scirus (39.0 per cent) and OCWfinder (42.7 per cent), but is lagging far behind the general search engines. Regarding videos, Scirus (43.5 per cent) surpasses OCWfinder (23.9 per cent), but lags behind it in audio media (39.1 per cent) and PDF (37.4 per cent), against 44.9 per cent and 48.1 per cent, respectively, by OCWfinder. Overall, OCWfinder is better than Scirus. Ask.com (76.1 per cent) and HotBot (76.1 per cent) stand shoulder to shoulder in retrieving videos, but for PDFs and audios HotBot is more efficient than Ask.com by a high per cent. IncyWincy, which claims to index the invisible Web, is itself invisible on the graph with 0 per cent performance. Google (73.6 per cent) is the best in retrieving OCW followed by HotBot (69.5 per cent) and Ask.com (63.1 per cent). Alta-Vista is in the middle (52.4 per cent). Scirus (39.0 per cent) and OCWfinder (42.7 per cent) both performed poorly. IncyWincy is the poorest (0 per cent). Comprehensive details are displayed in Figure 4.

Cumulative retrieval efficiency of different search engines

Google retrieved 181 out 246 documents which is the maximum retrieved in the present study, hence it ranks first. With 69.5 per cent recall, HotBot holds the second position. Ask.com and Alta-Vista are in third and fourth positions, respectively. The specialized search engines, Scirus and OCWfinder, retrieved fewer than 50 per cent of the documents as such, so rank fifth and sixth, respectively. IncyWincy retrieved no documents, although it claims to index 200 million Web pages. Comprehensive details are shown in Figure 5.

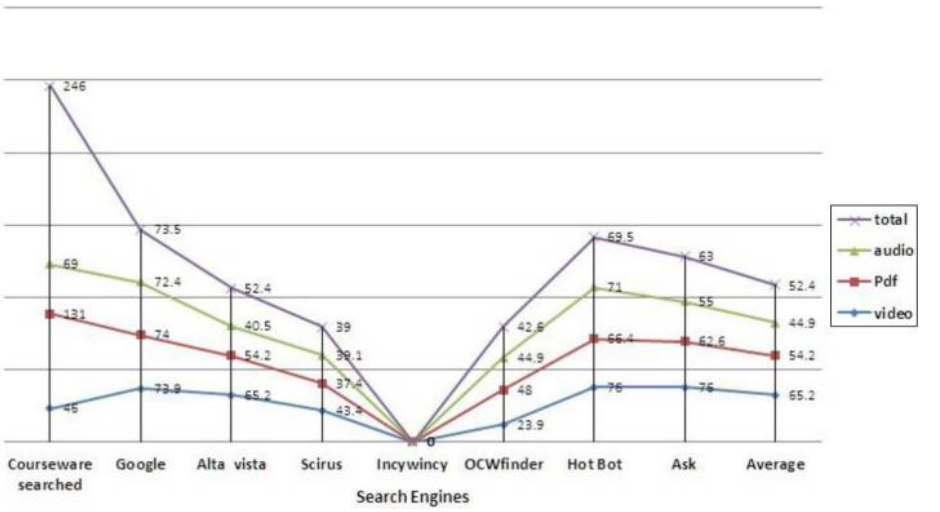

Figure 4.
Recall of search engines by format

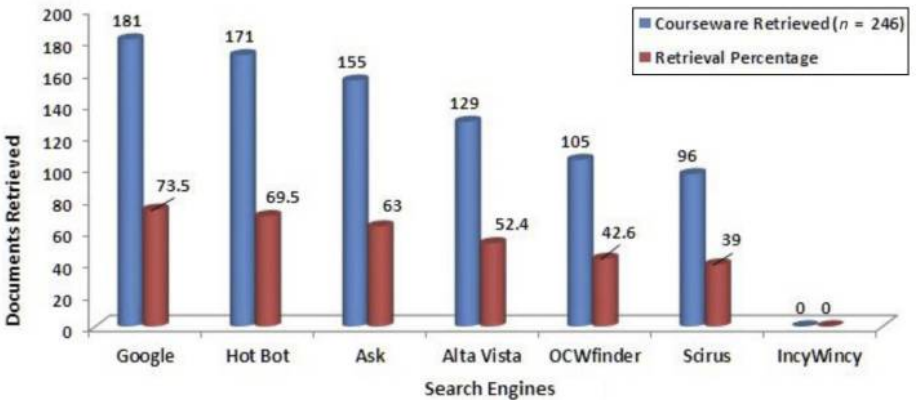

Figure 5. Cumulative retrieval percentage by select search engines

Findings

The major findings of the study are:

- retrieval of an OCW is affected by the format in which it is available;
- the video format is the most visible (65.2 per cent) form of OCW;
- for PDF resources, Google retrieved the maximum documents (74.1 per cent);
- HotBot and Ask.com, with a 79.1 per cent retrieval rate, are the most suitable search engines for retrieving OCW videos;
- audio courseware are most effectively (72.5 per cent) retrieved by Google;
- OCWfinder, which is a specific search engine for searching open courseware, has shown unsatisfactory performance (42.7 per cent);
- Scirus, despite its claim to index 460 million scientific Web pages including courseware, has shown poor performance (39.0 per cent) as compared to general search engines (73.6-52.4 per cent).
- IncyWincy, which claims to index 200 million Web pages, has shown dismal performance (0 per cent) in retrieving open courseware; and
- general search engines (73.6-52.4 per cent) are very good at retrieving OCW and have surpassed other search engines (42.7-0 per cent).

Summary and conclusions

The study gauged the visibility of OCW from some of the world's best open repositories and examined the relationship between the format of a resource and its visibility. It is evident from the diversity of OCW and their formats that academic circles and the educational community worldwide have recognized the importance of open courseware. Day by day, every college/university is keen to host its own OCW repository for its students in particular, and for the public in general (Bays, 2009, as cited in Kursan and Cagiltary, 2011). OCW has made lifelong learning a reality. It offers excellent opportunities for those persons who, despite having craving for knowledge, cannot afford regular education because of their occupation, lack of time, distance and related challenges. Students who receive education through the traditional mode can reinforce

their learning through these OCW. Open coursewares can help them by enriching their experience through multimedia and simulations. However, despite having such promising benefits, OCWs have not reached their full potential because of lack of information about their existence. Ordinary users are usually unaware of courseware in their related field. Nowadays, users want every answer from Google and similar search engines which usually do not include such courseware because of their poor visibility. Therefore, it is imperative that managers of OCW repositories use modern search engine optimization techniques to enhance the visibility of their OCW on search engines. Visibility can be increased by submitting a link to the search engine, sponsoring ads in online marketing portals, incorporating appropriate metatags in the source code, by collaborating with others to increase in-links to the repository and so forth. Increased footprints on social media will also help OCW repositories to achieve improved ranking in search engines. URLs and links can be submitted to search engines and directories for enhanced indexing. Similarly, search engine databases should be updated and improved so that they can incorporate results from OCW repositories in their results.

Regional and global consortia of OCW must be encouraged to provide a common platform for developers and users of OCW, and information professionals should play a pivotal role in organizing such consortia. Users must improve their search skills so that they can locate resources efficiently and accurately. Librarians should play a more active role in optimizing the use of OCW by making their patrons aware of such resources and frequently referring to them in their daily reference queries. Further research needs to be initiated on different aspects of OCW, such as user perspective studies and OCW growth and development which can help to visualize and plan a future course of action for sustaining a successful OCW repository.

References

Abeywardena, I.S., Dhanarajan, G. and Chan, C.S. (2012), "Searching and locating OER: barriers to the wider adoption of OER for teaching in Asia", paper presented at the Proceedings of the Regional Symposium on Open Educational Resources.

Akakandelwa, A. (2011), "An exploratory survey of the SADC e-government websites", *Library Review*, Vol. 60 No. 5, pp. 421-431.

Bhat, M.H. (2009), "Interoperability of open access repositories in computer science and IT – an evaluation", *Library Hi Tech*, Vol. 28 No. 1, pp. 107-118.

Bossu, C. and Tynan, B. (2011), "OERs: new media on the learning landscape", *On the Horizon*, Vol. 19 No. 4, pp. 259-267.

Bowler, L., Hong, W. and He, D. (2011), "The visibility of health web portals for teens: a hyperlink analysis", *Online Information Review*, Vol. 35 No. 3, pp. 443-470.

Brown, J.S. and Adler, R.P. (2008), "Minds on fire: open education, the long tail and learning 2.0", *Educause Review*, Vol. 18, available at: http://open.umich.edu/oertoolkit/references/mindsonfire.pdf (accessed 2 June 2012).

Chu, H., He, S. and Thelwall, M. (2002), "Library and information science schools in Canada and USA: a webometric perspective", *Journal of Education for Library and Information Science*, Vol. 43 No. 2, pp. 110-125.

Chu, H. and Rosenthal, M. (1996), "Search engines for the World Wide Web: a comparative study and evaluation methodology", *Proceedings of the 59th ASIS Annual Meeting*, available at: http://cui.unige.ch/tcs/cours/algoweb/2002/articles/art_habashi_arash.pdf (accessed 2 June 2012).

Clarke, S. and Willett, P. (1997), "Estimating the recall performance of web search engines", *Aslib Proceedings*, Vol. 49 No. 7, pp. 184-189.

Dicheva, D. and Dichev, C. (2014), "Finding open educational resources in computing", *2014 IEEE 14th International Conference on Advanced Learning Technologies (ICALT): An Asian Perspective on Policies and Practice*, *Penang, Malaysia*, pp. 22-24.

Didegah, F. and Goltaji, M. (2010), "Link analysis and impact of top universities of Islamic world on the world wide web", *Library Hi Tech News*, Vol. 27 No. 8, pp. 12-16.

Ding, W. and Marchionimi, G. (1996), "A comparative study of web search service performance", *Proceedings of the 59th ASIS Annual Meeting 33*, *Baltimore, MD*, *21-24 October 1996*, pp. 136-142, available at: http://eric.ed.gov/ERICWebPortal/search/detailmini.jsp?_nfpb=trueand_andERICExtSearch_SearchValue_0=EJ557172andERICExtSearch_SearchType_0=noandaccno=EJ557172 (accessed 4 June 2012).

Drez, X. and Zufreyden, F. (2011), "Measurement of online visibility and its impact on Internet traffic", *Journal of Interactive Marketing*, Vol. 18 No. 1, p. 22.

Elgohary, A. (2008), "Arab universities on the web: a webometric study", *The Electronic Library*, Vol. 26 No. 3, pp. 374-386.

Erfanmanesh, M.A. and Didegah, F. (2010), "The study of 15 public universities' performance on the World Wide Web", *Library Hi Tech News*, Vol. 27 No. 3, pp. 7-11.

Erfanmanesh, M.A. and Didegah, F. (2011), "Visibility and impact of Iranian research institutions on the web", *Library Hi Tech News*, Vol. 28 No. 1, pp. 4-9.

Gao, Y. and Vaughan, L. (2005), "Web hyperlink profiles of news sites: a comparison of newspapers of USA, Canada, and China", *Aslib Proceedings: New Information Perspectives*, Vol. 75 No. 5, pp. 398-411.

Gordon, M. and Pathak, P. (1999), "Finding information on the World Wide Web: the retrieval effectiveness of search engines", *Information Processing and Management*, Vol. 35 No. 2, pp. 141-180.

Griesbaum, J. (2004), "Evaluation of three German search engines: Alta-vista.de, Google.de and Lycos.de", *Information Research: An International Electronic Journal*, Vol. 9 No. 4, available at: http://eprints.rclis.org/5746/1/paper189.html (accessed 1 March 2014).

Jansen, B. and Pooch, U. (2001), "A review of web searching studies and a framework for future research", *Journal of the American Society of Information Science Technology*, Vol. 52 No. 3, pp. 235-246.

Kumar, B.T. and Prakash, J.N. (2009), "Precision and relative recall of search engines: a comparative study of Google and Yahoo", *Singapore Journal of Library and Information Science*, Vol. 38, pp. 127-134.

Kursan, E. and Cagiltary, K. (2011), "Open educational resources, opportunities and challenges for Turkish higher educational institutions", paper presented at the International Higher Educational Congress; New Trends and Issues Conference, Istanbul, available at: www.academia.edu/579678/Open_Educational_Resources_Opportunities_and_Challenges_for_Turkish_Higher_Educational_Institutions (accessed 23 December 2014).

Leighton, H.V. and Srivastava, J. (1999), "First 20 precision among World Wide Web search services (search engines)", *Journal of the American Society for Information Science*, Vol. 50 No. 10, pp. 870-881.

Lewandowski, D. (2011), "The influence of commercial intent of search results on their perceived relevance", *ACM Proceedings of the 2011 Conference*, *Seattle, WA*, *8-11 February 2011*, pp. 432-451.

Open Courseware Consortium (2012), *What Is Open Courseware?*, available at: http://ocwconsortium.org/en/aboutus/whatisocw (accessed 2 June 2012).

Piedra, N., López, J., Chicaiza, J. and Caro, E.T. (2014), "Serendipity: a platform to discover and visualize open OER data from open courseware repositories", *Proceedings for Open Education Multicultural World (OCWC)*, available at: http://conference.oeconsortium.org/2014/wp-content/uploads/2014/02/Paper_82-serendipity.pdf (accessed 1 March 2014).

Reyneke, M., Pitt, L. and Berthon, P.R. (2011), "Luxury wine brand visibility in social media: an exploratory study", *International Journal of Wine Business Research*, Vol. 23 No. 1, pp. 21-35.

Russell, J.M., Aguilar, J.D. and Ainsworth, S. (2012), "Web visibility or wasted opportunity? Case studies from Mexican research institutes", *Aslib Proceedings*, Vol. 64 No. 1, pp. 67-82.

Shafi, S.M. and Rather, R.A. (2005), "Precision and recall of five search engines for retrieval of scholarly information in the field of biotechnology", *Webology*, Vol. 2, available at: www.webology.org/2005/v2n2/a12.html (accessed 2 June 2012).

Shirley, A. (2001), "E-learning developments and experience", *Education + Technology*, Vol. 43 Nos 4/5, pp. 240-248.

Silverstein, C., Henzinger, M., Marais, H. and Moricz, M. (1999), "Analysis of a very large web search engine query log", *SIGIR Forum*, Vol. 33 No. 1, pp. 6-12.

Sowards, S.W. (2004), "Visibility as a factor in library selection of ready reference web resources", *Reference Services Review*, Vol. 33 No. 2, pp. 161-172.

Vaughan, L. (2004), "New measurements for search engine evaluation proposed and tested", *Information Processing and Management*, Vol. 40 No. 4, pp. 677-691.

Veronis, J. (2006), "A comparative study of six search engines", available at: http://usuarios.multimania.es/webbuscadores/2006_comparative_study.pdf (accessed 2 June 2012).

Vladoiu, M. (2013), "Toward increased discoverability of open educational resources and open courseware", *International Journal of Computer Trends and Technology*, Vol. 4, available at: www.unde.ro/monica/papers/X06-IJCTT-2013-Towards%20increased%20discoverability%20of%20OERs%20and%20OCW.pdf (accessed 1 March 2014).

Wu, S. and Li, J. (2004), "Effectiveness evaluation and comparison of web search engines and meta-search engines", *Advances in Web-Age Information Management*, Springer, Berlin, pp. 303-314.

Yi, K. and Jin, T. (2007), "Hyperlink analysis of the visibility of Canadian library and information science school websites", *Online Information Review*, Vol. 32 No. 3, pp. 325-347.

Further reading

Lewandowski, D. (2008), "Problems with the use of web search engines to find results in foreign languages", *Online Information Review*, Vol. 32 No. 5, pp. 668-672.

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