

Open Data Benchmarking for Higher Education: Management and Technology Perspectives

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Abstract

Along with many trends in Higher Education (HE) sector and data-smart education, open data becomes a key issue for innovations in the Data Era. This conceptual article highlights the significance of using open data for HE benchmarking and tries to answer the question “Are the universities ready for benchmarking using open data?”. Based on a literary review and a desk research method, the article starts with a short overview of university benchmarking practices and benchmarking data. The study discusses open data and HE open data and portals. The article finds that one of the difficult steps in the HE benchmarking process is data gathering, most of the data are available from data sources, which have to be analyzed additionally, the data cannot be reused and has to be investigated through labor and time consuming activities. The paper outlines that there is a potential for implementation of open data benchmarking at HE and concludes with the key management and technologies perspectives.

Keywords: Education, Open data, Higher Education, KPIs

Introduction

Higher Education (HE) is being promoted to support the academic standards and as a vehicle for improving educational, administrative and business processes in a globally competitive academic environment. Measuring HE performance against a recognized education excellence can deliver a range of benefits for HE organizations. Currently, the university benchmarking practices show the broad spectrum of measurements while the core question regarding benchmarking is gathering, the availability and update frequency of the data.

HE Benchmarking is implemented on international (Phillips, 2014; Burquel and Van Vught, 2010), national (McKinnon, 2000) and organizational level. For example, a study held by OECD tries to explain educational performance and economic growth across world regions (OECD, 2010). The basic estimation employed a sample of 23 OECD countries for which appropriate economic data were available. A key element of the work was developing a common measure that can equate knowledge of individuals across countries. Similarly, UNESCO Institute for Statistics, the leading source for international education statistics, covers more than 200 countries and territories in order to assess the education in different perspectives from pre-primary school enrolment to tertiary graduation rates. The UIS database covers all education levels and addresses key policy issues such as gender parity, teachers and financing. HE benchmarking practices are applied globally, in UK, Europe, Australia, and North America (Dias, 1998). An example

of education performance assessment is the Stanford University's study about Learning Systems in Finland and Sweden, Australia, Hong Kong, Singapore, UK and US. It explains student performance assessment in international context and shows that higher-achieving countries teach fewer topics more deeply each year, focus on applications of knowledge, rather than recall of facts, and have a more thoughtful sequence of expectations based on development learning progressions within and across domains(Darling-Hammond & Wentworth, 2010).

I. University benchmarking

According to APQC, “benchmarking is the process of identifying, understanding and adapting outstanding practices and processes from organization anywhere in the world by a firm to improve its performance” (APQC, 1993). Benchmarking is the process of improving performance by continuously identifying, understanding, and adapting outstanding practices and processes found inside and outside an organization (public organization, University, College, etc.)(Spendolini, 1992), SeeFigure 1.

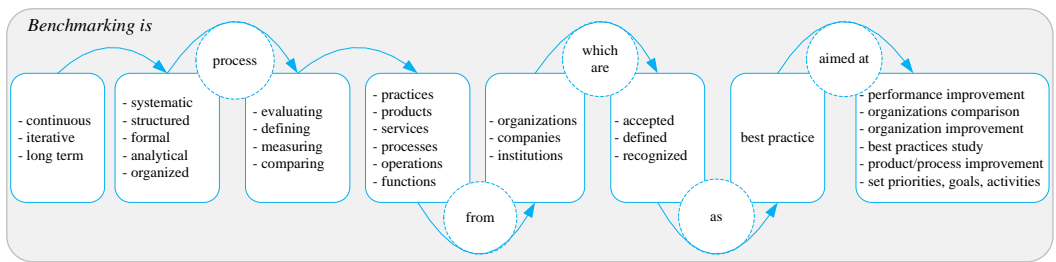


Figure 1 Benchmarking“Menu”

HE benchmarking has been used for a diversity of purposes (Kuźmicz, 2015;Tijssen, Van Leeuwen, and Wijk Van, 2009). According to Nazarko, et al., the aim of benchmarking in HE is the improvement of the national or international competitiveness of universities (Nazarko, et al, 2009). Universities apply benchmarking for analyses and improvements of curricula (Edwards, Coates and Radloff, 2009), formal assessment and accreditation services. It is also used for informal learning, based solely on open educational resources (Murphy, A.), for program, subject and institutions (DEI, 2003), for academic development (Maconachie, D. et. al, 2011), for student performance, satisfaction and engagement(BI USA), for quality assurance (Curtin, C. et al, 2010), quality improvement in technology enhanced learning(Sankey, M. et al, 2014) and many others. Amongst the many challenges ofHE benchmarking is gathering the data/information and the availability and update frequency of data(Fice, and Waller, 2012).

Data for HE (University) benchmarking can be one of the most difficult step of the process, depending on the type of benchmarking (internal; external; collaborative; cooperative; competitive; interdisciplinary; etc.) and its purpose(Dias, 1998). For example, when cooperative benchmarking is applied, the data is accessible only to the participating parties.HE data can be related to (Guy, 2014):

- Student data: attendance, grades, skills, exams, homework;

- Course data: employability related to courses, curriculum, syllabus, number of textbooks, skills, digital literacy;
- Institution data: location data, results, infrastructure, location, student enrolment, textbook budget, teacher details;
- User-generated data: learning analytics, assessments, performance data, job placements, laptop data, time on tasks, use of different programs/apps, web site data;
- Policy/Government data: equity, budgets, spending, UNESCO literacy data, deprivation and marginalization in education, participation data.

Researches show that the data for benchmarking can broadly vary. For example, benchmarking project carried out by Leiden University, data was extracted from the Web of Science (WoS), international, multidisciplinary bibliographical database including international technical reviewed journals(Tijssen, Van Leeuwen, and Wijk, 2009). In order to benchmark the procurement practices, the University of Newcastle gathered data through interviews with managerial workers and questionnaires(Young, Ruamsook and Purdum, 2007). According to Open Education Working Group(OEH, 2014), there are many different types of data that can be relevant to education (HE) and come from education. For example, relevant sources might include:

- Publications & literature: ACM, DBLP (L3S), Open Library;
- Domain-specific knowledge & resources: Bioportal for Life Sciences;
- Historic artefacts in Europeana, Geonames;
- Cross-domain knowledge: DBpedia, Freebase, etc.;
- (Social) media resource metadata: BBC, Flickr, etc.

Data for university benchmarking can be gathered based on a diversity of methods and sources. In almost all of the given studies, the data are closed and only participating parties can use it, or the data is processed and aggregate. Raw data gathered through surveys is not accessible, and only the results of the surveys are discussed. The data from education institutions such as associations and statistics, is accessible, but in most of the cases, it is in a compound form and do not allow reuse. For example, USA National Center for Education Statistics (NCES) allows Compare Institutions, the database includes 7,000 institutions and up to 250 variables. Data files are provided in comma separated value (*.csv) format (NCES). UNESCO Stat contains all the latest available data and indicators, for education, literacy, science, technology and innovation, culture, communication and information. World Bank EdStats Data Catalog holds learning outcome data from international and regional learning assessments (e.g. PISA, TIMSS, PIRLS), equity data from household surveys, and projection/attainment data to 2050. According to McKinnon, et.al, (McKinnon, et. al, 2000) there are three types of data problems for university benchmarking:

1) Data may not be comparable because of different reporting conventions among States. Even financial data, while accurate and complete to the satisfaction of each State

Government Auditor General, follows different accounting conventions across State jurisdictions, which, in turn, prevents fully comparable pictures of financial health.

2) Instruments that will produce comparable data are lacking. For instance, most universities survey student opinion in various ways: a few also survey staff attitudes. Although there are sometimes common questions, universities until now have preferred to stress their diversity rather than their commonality. The benefits of common comparable data are such that efforts to improve existing instruments and expand the pool of common data would be fruitful.

3) While the quality of most statistical data about Australian universities is good, there is distrust among universities, centering on what some claim to be room to fudge the data while staying within the definitions. Further work on better definitions, allowing less room for doubt about the accuracy of data, is necessary.

II. Data and University benchmarking

There are many examples of university benchmarking data sources (PA CC, 2011). US National Association of College and University Business Officers (NACUBO) provides five data sources for benchmarking: general data; endowment and finance data; facilities data; salary and benefits data; tuition discounting data (NACUBO). Data source can be grouped into:

- Internal - Library data bases, Internal reviews, International publications;
- External - Professional associations, Industry publications, Special industry reports, Functional trade publications, General management, Seminars, Industry data firms, Software hardware firms, Advertisement, Newsletter;
- Original Research - Customer feedback, Telephone survey, Inquiry service, Networks, Consulting firms.

For instance, information on benchmarking partners can be obtained from libraries, professional associations, personal contacts, and data sharing consortia (Alstete, 1995). The source of data depends upon the benchmarking area and data type (JCU, 2015). Table 1 shows education sector data sources for university activities benchmarking (HESA UK, 2010).

Table 1 Education sector data sources

University benchmarking activity	Sector data sources (UK and world)
Strategic planning and administration	Heidi, HESA publications, ad hoc information services and Performance Indicators, UCAS, Unistats, National Student Survey, Data.gov.uk , Universities UK (UUK), Higher Education Policy Institute (HEPI), the British Council, Research Libraries UK, the Universities Health and Safety Association (UHSA), County Councils, Office for National Statistics (ONS)
Student services	
Teaching (effectiveness of teaching)	
Research activity (monitor and manage)	
Estates	
Finance	

(providing a strategic financial perspective on higher education activities)	(demographic data and employment trends), HM Treasury, Department of Education, CBI, OECD, World Statistics com, etc.
Human Resources (Monitor and measure the impact of people management practices across the institution)	
Library services	

Fice and Waller define a benchmarking maturity framework based on three levels of maturity (Fice and Waller, 2012). The source of data is layered as:

- level 1 - Source data compiled on one-off and ad hoc basis. Questionable quality and comparability of data. Localised sources of data held within departments that are not accessible to all staff and are not trusted across the institution;
- level 2 - Data feeds taken from good quality sources at regular intervals. Comparability ensured to high degree. Visibility and sharing of data between departments. Increasing trust in the data arising from developing consistency and transparency of data gathering processes.
- level 3 - Quality-assured internal and external data which is maintained as a central institutional resource. Integrated and coordinated approach to data gathering and update promoting timely and consistent data – “one version of the truth” that is trusted across the HE institution. Adherence to data standards ensuring comparability and stability over time (Fice and Waller, 2012).

The availability of data is a key for benchmarking measurement. When data are available, the benchmarking KPIs can be measured. UK study shows that when measuring HE performance, the purpose of performance measurement/indicators should be (Schofield, A.): accountability, usually regulatory or funding bodies monitoring compliance; centrally driven performance enhancement and institutionally driven performance enhancement. Similarly, the UK complete university ranking is based on indicators such as entry standards, student satisfaction, research assessment, research intensity, graduate prospects, student-staff ratio, academic services and facilities spend, good honors and degree completion (ULT, 2015). Table 2 shows common indicators used in dashboards by US Universities (Cubie, 2006).

Table 2 KPI Category

Category	Indicator Group
Financial Indicators	Endowment & Expenses Data; Advancement; Financial Aid Figures; Fees/Tuition Data
Admissions	Admissions Scores; General Admissions Data; Graduate Admissions
Enrolment	Enrolment Figures; Enrolment Figures (Special Population)
Faculty	Faculty – General; Faculty Composition - Special Population
Student	Outcomes Graduation Rates; Retention Rate; Measures of

	Success; Enrolment Awards; Graduation Rates - Special Population
Student Engagement	Student Body – Engagement
Academic Information	Student/Faculty contact; Academic Information
Physical	Plant Physical Plant
Satisfaction	Student Satisfaction; Employer/Staff, Other Satisfaction; Faculty Satisfaction
Research	Research
External Ratings	Peer Assessment Data

In his research, Schofield, A. explains the need for KPIs for HE institutions measurement and uses three KPIs types – input, process, output and outcome(Schofield, A.). Likewise, a research for measuring educational quality applies basic systems model on the functioning of education and develop indicators for input, process and output(Scheerens, J. et al., 2011): input - financial and human resources invested in education; process - access, participation, progression transition school to work learning environment and organization; output/Outcomes - achievement labour-market outcomes. KPIs can be related to staff, management, governing body, government or funding bodies. They have to be ensuring robust and reliable data over time and publicity given. On one hand, the researches show that university conduct benchmarking using data, which is not accessible to other groups of interests. The university data is not delivered and used by user groups, such as citizens, employees, business, NGOs because they are not accessible (Figure 2). On the other hand, many universities have started open data initiatives and open data mainly for education purpose, such as MOOCs and research databases.

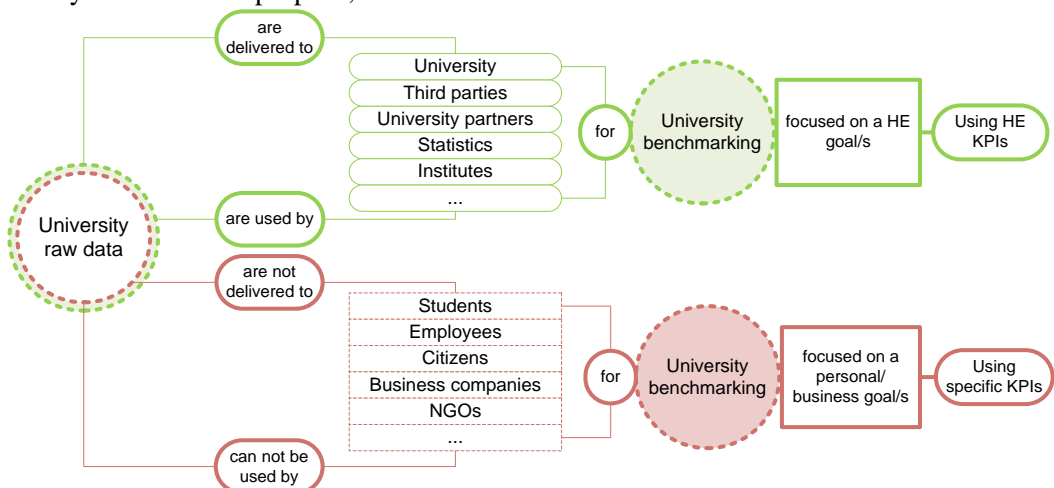


Figure 2 University data user groups

The universities use benchmarking for improvements in performance or activities, operations and processes, GAP analysis and many others purposes. The usage of data in most HE benchmarking practices is based on the universities raw data, through the benchmarking indicators measurement. In most of the cases, the universities or other

organizations that use benchmarking have predefined goals and use different methods to gather the necessary data about the universities.

Studies show that, even though the university data users are the universities, institution, statistics, etc., there are other user groups such as students, university employees, business companies and NGOs, which can be interest in different aspects of comparisons. For example, university data can be used by business for developing innovative projects/apps through mashup technologies, students can raise ideas for university improvements based on university hackathons, and employees can use university raw data for professional development using identical data for comparison with the best performance employee.

Educational institutions, research centers, government bodies, IT experts and developers, citizens and business use open data benchmarking to assess HE performance in different perspectives. On Figure 4, it is explained the definition about Open Data Benchmarking.

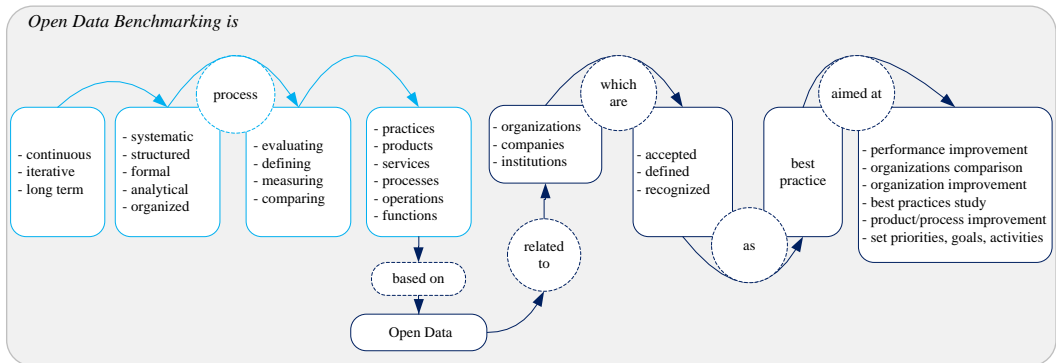


Figure 4 Open data benchmarking definition

III. University Open data and Open Data Portals

Many public organizations produce and collect a broad range of different types of data in order to perform their tasks. Two main civil society movements are campaigning for greater openness of information, documents and datasets held by public bodies. The first is the - Right to Information movement, which promotes a public right of access to information from a human rights perspective. The second is the - Open Government Data movement, which uses predominantly social and economic arguments to encourage the opening up of government data (Ubaldi, 2013).

1.1. Open data in HE

Open government data or Open data usually refers to public sector records (e.g. education, transport, environment, etc.) (EC, 2011). The eight principles of open government data states that, data shall be considered open if they are complete, primary, timely, accessible, able to be processed by machine, non-discriminatory, non-proprietary and license-free (Tauberer, J.). Open data principles also highlight the importance of datasets being as authoritative, timely (published soon after collection), and as raw

(granular data, shared prior to aggregation or analysis) as possible, in format such as, JSON, XML, RDF, Spreadsheets, CSV, HTML, etc., which can be used for benchmarking purposes. Open data should be both technically and legally open – in the sense that it is technically available and usable, and appropriate licensing frameworks are in place to facilitate its release and use.

The open data trends show that the speed of publicizing data goes beyond the potential for gaining value for all spheres of society, economy, and business and for the most part for education. The many sources of government data offer potential value for society – but the value will be realized only if government information policies and practices are better aligned with the needs of external users (Dawes, 2012). Research on open education shows that there are many sources about research data and output (Erway, 2013), (OECD, 2007) and open learning resources having education purposes, such as MOOC (Voss, 2013). Open HE data refer specifically to the open data that comes out of educational institutions (HE) - all physical places of study from schools to further education and universities. This refers to administrative data, which could include reference data such as:

- the location of academic institutions;
- internal data such as staff names, resources available, budgets data;
- course data, curriculum data, learning objectives;
- user - generated data such as learning analytics, assessments, performance data, job placements.

Figure 5 shows the path from public sector data to university open data.

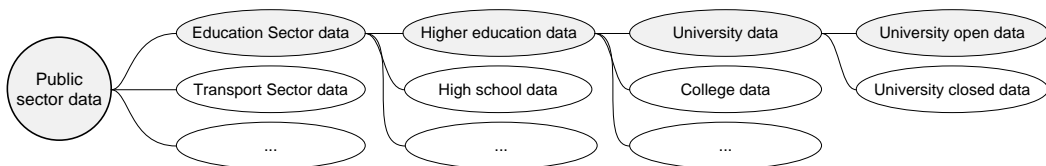


Figure 5 Public sector - university open data

1.2. University open data portals

A data portal provides access to open datasets, hosting meta-data that describes them, and allowing visitors to search for relevant datasets. Currently, there are hundreds open data globally. For example, more than 130 portals have been built using CKAN data management platform. Data portals (<http://dataportals.org/>)” is a comprehensive list of portals from around the world, which includes 417 portals. Data portals can be national, regional, city, organizational, etc. On national data portals, such as Data.gov.uk, Data.gov, Data.gov.au, can be found education related data. Research on datasets show that, the datasets on national portals are few or there are no data sets.

Good practice of open data initiative is the Queensland Universities’ Open Data Strategy 2014-2017. The strategy accent on the number of data sets about the sector already

available on a national basis and additional data sets reside within individual universities and that universities will aim to take advantage of existing data sets where appropriate.

On a University level, open data initiatives are on different aspects. An example for Open data portal is the University of Southampton(ARIADNE), (Figure 6). The data catalog includes: Academic Courses; Academic Sessions; Apps using data; Building Entrances and Exits; Buildings and Places; Daily Menus; Electronics and Computer Science ePrints Repository; Local Amenities; Multi-Function Devices; Room Divisions; Southampton Bus Information; Student Statistics; Vending Machines, etc.

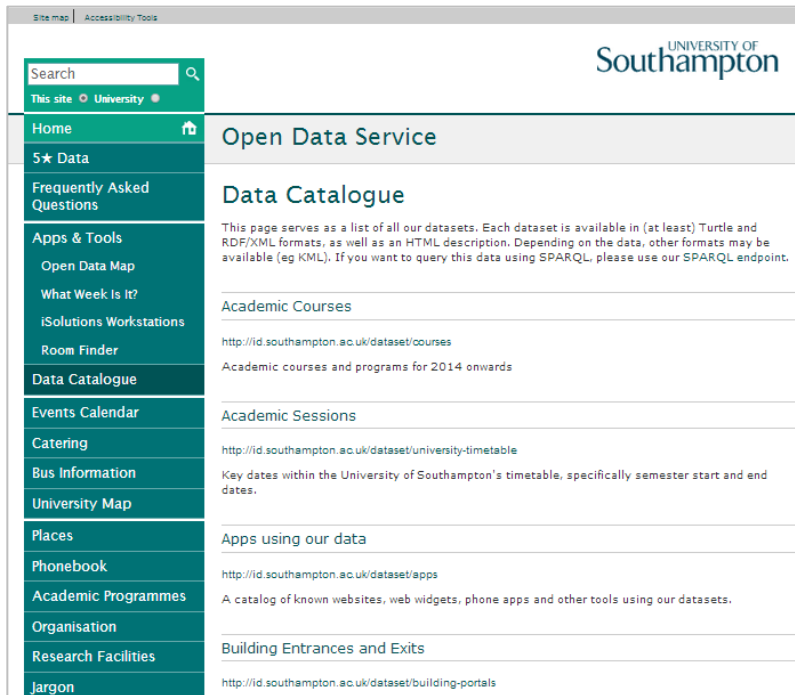


Figure 6 University of Southampton open data portal

The open data service brought together datasets on many aspects of university life such as locations, course details, people and travel information. The views on the data allow finding out what coffee shops are open on campus, what they sell and how to locate them. It also offers information on what courses are on at what time and whether students rate them highly. Another example is the open data portal of Open University UK. The datasets relate the publications, qualifications, courses and Audio/Video material produced at the Open University, as well as the people involved in making them. Published datasets include data about Aalto University, Finland on data catalog site are about courses, publications, research projects, places, such as buildings, researchers and staff, organizational structure, news and events. The open data portal of Universitat Pompeu Fabra (UPF), Spain has developed not only open data catalog site but also an OpenData strategy.

Conclusion

Open Education and open practices could have a significant impact on all domain of the education. How open data and open data benchmarking can be used for better HE services and improving HE performance is still not much discussed today. Benchmarking itself is often difficult to implement because of the difference in data, data gathering methods and sources of data, which are accessible only to the organizations that conduct benchmarking. Research show that university benchmarking practices depends upon the educational management of the institutions. Consequently, key questions about the implementation of open data benchmarking is related to the strategic vision about open data practice, open data usage at the HE, readiness for open agenda of the institution, qualification and expertise of people engaged in open data practices, and the values that open data benchmarking can generate. Other HE open data benchmarking key issues are related to the prioritization of opening data, data formats and if the institution would invest in open data portal and technology. This is why data management technology is of great importance. What data management system to be used - open sourced or web based, what is the time frame for the implementation of the technology and what are best practices for HE open data portals, these are some of questions to be analyzed. The HE organizations have to activate their engagements towards opening data and to prioritize the data which to be open, to analyze the strength and weaknesses, opportunities and threats of open data initiatives and to initiate activities for open data strategy development for the purpose of performance improvement. Even though, HE organizations have started open data initiatives such as open research data and open learning resources, they do not open data related to management and organization, for example the data about the infrastructure, employees or the administration data. The limitation also comes from the not fully used potential of the data and the accessibility to data, which can be used by other user groups such as citizens and business.

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References

- Aalto University data catalog, Finland, <http://data.aalto.fi/>
- Alstete, J.W. (1995) Benchmarking in Higher Education, Adapting best practices to improve quality, US Department of Education, <http://files.eric.ed.gov/fulltext/ED402801.pdf>
- American Productivity and Quality Center, <https://www.apqc.org/benchmarking-portal>
- ARIADNE, LinkedUp: Linking Open Data for Education, <http://www.ariadne.ac.uk/issue72/guy-et-al>
- Australia's Open Research Data Collections, <http://www.andis.org.au/partner/open2015posters/>
- Benchmarking Institute (BI), National Community College Benchmark Project, USA, <http://nccbp.org/benchmarks>

- Burquel, N. and Van Vught, F. (2010). Benchmarking in European Higher Education: A step beyond current quality models. *Tertiary Education and Management* 16.3 (2010): 243-255.
- CKAN, <http://ckan.org/instances/#>
- Cubie , A. (2006). CUC Report on the Monitoring of Institutional Performance and the Use of Key Performance Indicators, http://www2.bcu.ac.uk/docs/cuc/pubs/KPI_Booklet.pdf
- Curtin, C. et al (2010). Institutional Self-Assessment Report, National University of Ireland, Galway, <http://www.nuigalway.ie/quality/downloads/2010isareport.pdf>
- Danish Evaluation Institute (DEI) (2003). Quality procedures in European Higher Education, [http://www.enqa.eu/indirme/papers-and-reports/occasional-papers/procedures\(1\).pdf](http://www.enqa.eu/indirme/papers-and-reports/occasional-papers/procedures(1).pdf)
- Darling-Hammond, L., Wentworth, L. (2010). Benchmarking Learning Systems: Student Performance Assessment in International Context, <http://www.ncee.org/wp-content/uploads/2010/11/BenchmarkingLearningSystemHAMMOND.pdf>
- Dawes, Sh. (2012). A Realistic Look at Open Data, CTG, SUNY, USA, http://www.w3.org/2012/06/pmod/pmod2012_submission_38.pdf
- Dias, M. (1998) Benchmarking in Higher Education A study conducted by the Commonwealth Higher Education Management Services, UNESCO, <http://unesdoc.unesco.org/images/0011/001128/112812eo.pdf>
- Edwards, D., Coates, H., Radloff, A. (2009). The contribution and standards processes of private higher education providers, Australian Council for Educational Research, <http://goo.gl/4BP0Rz>
- Erway, R. (2013). Starting the Conversation: University-wide Research Data Management Policy, Online Computer Library Center, Inc., <http://www.oclc.org/content/dam/research/publications/library/2013/2013-08.pdf>
- European Commission (2011). Digital Agenda: Turning government data into gold, http://europa.eu/rapid/press-release_IP-11-1524_en.htm
- Fice, G., Waller, J. (2012). A strategy-contingent approach to benchmarking, HESA Benchmarking Project, JISC Info Net, <http://www.jiscinfonet.ac.uk/infokits/benchmarking/strategy-contingent-approach/measure/>
- Guy, M. (2014) Open data in education, <http://www.slideshare.net/MariekeGuy/edtalk2>
- Higher education statistics agency UK (HESA UK) (2010) Benchmarking to improve efficiency Status Report, https://www.hesa.ac.uk/dox/Benchmarking_to_improve_efficiency_Nov2010.pdf
- James Cook University (JCU) (2015). Quality and Standards, Australia, http://www.jcu.edu.au/quality/JCUPRD_045053.html
- Kuźmicz, K.A. (2015) Benchmarking in university toolbox, *Business, Management and education* ISSN 2029-7491 / eISSN 2029-6169, 2015, 13(1): 158–174, doi:10.3846/bme.2015.259
- Linked Data from The Open University, <http://data.open.ac.uk/>
- Maconachie, D. et. al (2011). Benchmarking Performance of academic development units in Australian Universities, Council of Australian Directors of Academic Development, http://www.cadad.edu.au/pluginfile.php/401/course/section/78/Benchmarking_Report.pdf
- McKinnon, et. al, (2000). Benchmarking. A manual for Australian Universities, Commonwealth of Australia, http://science.uniserve.edu.au/courses/benchmarking/benchmarking_manual.pdf
- Murphy, A., Benchmarking OER Use and Assessment in Higher Education, University of Southern Queensland, https://eprints.usq.edu.au/21968/2/ORION_OER_use_and_assessment_Total_Results.pdf

- NACUBO, http://www.nacubo.org/Research/Benchmarking_Resources/Data_Resource_Details.html
- National Center for Education Statistics (NCES) <http://nces.ed.gov/ipeds/Home/UseTheData>
- Nazarko, et al (2009) The General Concept of Benchmarking and its Application in Higher Education in Europe, Higher Education in Europe, Vol. 34, Nos. 3–4, October–December, http://nazarko.pl/public/data/resource/upload/00003/2426/file/the_general_concept_of_benchmarking_and_its_application_in_higher_education_in_europe.pdf
- OECD (2007). OECD Principles and Guidelines for Access to Research Data from Public Funding, <http://www.oecd.org/science/sci-tech/38500813.pdf>
- OECD (2010). The High Cost of Low Educational Performance, <http://www.oecd.org/pisa/44417824.pdf>
- Open Access: making scholarly research outputs freely available to access online, <http://www.data.cam.ac.uk/files/20150513opendata.pdf>
- Open Data at the Pompeu Fabra University (UPF), <http://data.upf.edu/en/strategy>
- Open Education Handbook (OEH) 2014, <http://booktype.okfn.org/open-education-handbook-2014/types-of-open-data/>
- PA Consulting Group (2011). International Benchmarking in UK Higher Education, http://benchmarking.hesa.ac.uk/wp-content/uploads/2011/10/HESA_International_Benchmarking_report.pdf
- Phillips, G. (2014). International Benchmarking: State and National Education Performance Standards, American Institutes for Research, <http://goo.gl/LYkHRA>
- Queensland Universities' Open Data Strategy 2014-2017, <http://opendata.dete.qld.gov.au/corporate/queensland-universities-open-data-strategy-2014-2017.pdf>
- Sankey, M. et al (2014). ACODE Benchmarks for Technology Enhanced Learning, Australasian Council on Open, Distance and e-learning, http://www.acode.edu.au/pluginfile.php/579/mod_resource/content/3/TEL_Benchmarks.pdf
- Scheerens, J. et al. (2011). Measuring Educational Quality by Means of Indicators, In Scheerens, Jaap, Luyten, Hans, van Ravens, Jan (Ed.), Perspectives on Educational Quality, p.35-50, New York: Springer. http://www.springer.com/cda/content/document/cda_downloaddocument/9789400709256-c2.pdf?SGWID=0-0-45-1132975-p174098969
- Schofield, A. What Can Performance Measurement and Key Performance Indicators Do For Higher Education Institutions? a UK Perspective, <http://www.eua.be/eua/jsp/en/upload/Allan%20Schofield.1164100168269.pdf>
- Spendolini, M. (1992). The benchmarking book, American Management Association AMACOM, USA, p.10
- Tauberer, J., The Annotated 8 Principles of Open Government Data, <http://opengovdata.org/>
- Tijssen, R., Van Leeuwen, T., Wijk, Van E. (2009). Benchmarking university–industry research cooperation worldwide: performance measurements and indicators based on co-authorship data for the world's largest universities, DOI: 10.3152/095820209X393145, Beech Tree Publishing
- Ubaldi, B. (2013). “Open Government Data: Towards Empirical Analysis of Open Government Data Initiatives”, OECD Working Papers on Public Governance, No. 22, OECD Publishing. <http://dx.doi.org/10.1787/5k46bj4f03s7-en>
- UNESCO Institute for Statistics, <http://data.uis.unesco.org/>
- University League Tables (ULT) (2015). The complete university guide, <http://www.thecompleteuniversityguide.co.uk/league-tables/methodology/>
- University of Southampton Open Data Service, <http://data.southampton.ac.uk/>

- Voss, B. (2013). Massive Open Online Courses (MOOCs): A Primer for University and College Board Members, http://agb.org/sites/default/files/legacy/report_2013_MOOCs.pdf
- World Bank, <http://data.worldbank.org/data-catalog/ed-stats>
- Young, R., Ruamsook, K., Purdum, S. (2007). Benchmarking Procurement Practices in Higher Education, IBM Center for The Business of Government, <http://www.businessofgovernment.org/sites/default/files/Benchmarking.pdf>