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## Integration of Open Educational Resources Through Linked Data: Challenges and Benefits Review

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# **Integration of Open Educational Resources Through Linked Data:**

## **Challenges and Benefits Review**

### **Abstract**

**Purpose of the Study:** This study explores that how Linked Data (LD) technology can be implemented in educational sector to use Open Educational Resources (OERs) more effectively or what kind of benefits and challenges it retains for educational sector. Because now teaching is supported and integrated with the use of different interactive resources such as videos, blackboards and virtually available platforms in formal and informal education. The objective of this research study is to highlight the nature of LD and OERs and their associated benefits and barriers for educational sector that are related to the adoption of LD technologies in OERs.

**Research Methodology:** This paper is based on literature research methodology. It reviews national and international literature about the integration of OERs through LD technologies. Literature published after 2012 to till date was critically analysed to be included in the study.

**Research Findings:** The integration of OERs by using the LD is getting popularity in educational sector like other fields. It retains benefits not only for students but also for teachers too. The challenges of interoperability and standardization exists but these can be overcome by adopting principles at the beginning. Locally some projects are also initiated in Pakistan though these are in their infancy stage such as elearn and elibrary Punjab.

**Keywords:** Linked Data (LD), Open Educational Resources (OERs), semantic web, educational data, web data

## **1.1 Introduction and Literature Review**

In this digital era, huge amount of data is available through single clicks that can be shared or reused for multiple purposes by anyone at anyplace. Most of organizational and institutional educational repositories give open access to their resources, which can be interlinked, reused or shared by those who want to utilize. Bauer and Kaltenböck (2012) explained that the major concept of a semantic web is to “provide cost-efficient ways to publish information in distributed environments. To reduce costs when it comes to transferring information among systems, standards play the most crucial role. Either the transmitter or the receiver has to convert or map its data into a structure so it can be “understood” by the receiver” (p. 25).

The Association for Economic Co-operation and Development (OECD) defined (2007) Open Educational Resources (OER) as “digitized materials offered freely and openly for educators, students, and self-learners to use and reuse for teaching, learning, and research” (p. 1). This definition comprises different elements that facilitates the development, use and distribution of different types of educational resources based on free and open license.

Open Educational Resources (OERs) was coined by UNSECO (2015) which means that “teaching, learning and research materials in any medium, digital or otherwise, that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions” (p. 4). OERs potentially supports the use of educational material without any built-in and geographically restrictions. Guy (2016) identified that OERs supports the purpose of open educational data which is subset of OERs in which datasets are produced and share for learning and teaching.

On the other side, Linked Data technology helps in the publishing of structured data on web which might be OERs or any other type. Different fields of life are using Linked Data for exploration and publishing of data in different domains. Whereas, in educational sector it is an ignored area (Navarrete & Luján-Mora, 2015). This is not just putting the data over the web like HTTP documents, but also about making links between the documents or to explore and use more relevant data sources.

Different learning repositories are based on various standards and principles according to the needs and infrastructure. Linked data has emerged as a standard for the sharing of open data over the web and it provides potential solutions to resolve the issues of interoperability by using Uniform Resource Identifiers (URIs). Various terms are being used for linked data interchangeably as open data, linked open data, the web of documents, the web of web and semantic web (Mayernik, Phillips & Nienhouse, 2016).

In 2014, Halimi et al. discussed that web is neither built for machine consumption nor for human consumption. Everything over the web is not machine understandable but machine-readable. So, the interesting movement of semantic web will provide flexible, expressiveness and extensible representation of knowledge over the web through integration process. For the integration of data, it must be structured and open so it can be linked with other datasets for the provision of access to consumers (Saleem, Butt & Warriach, 2018).

In the beginning, the integration of educational resources was slow due to closed infrastructure of its resources but now it is rapidly catching up this strategy with the other fields of life. In education sector, the educators must learn how they can use new pedagogical strategies in their formal and informal teachings, so that they may perform

their role more efficiently and effectively in order to get more appreciation by the community (Ahmed, Shaik & Aouad, 2006; McKenney & Mor, 2015).

All fields of life and professions are developing and using Web-based applications as well as health and education. Linked data technologies give a set of opportunities for educators that are not limited by geographical distances. In this information age, where the focus is on how the information can be utilized in an effective way by the people of any community. Chamizo-Gonzalez et.al (2015) argued that the virtual learning tools and platforms such as object-oriented, modular and dynamic environment provide abundance of opportunities for the innovation in research and teaching strategies. It's a right time to equip themselves with technological innovations in order to remain over the head of the game.

Anderson and Whitelock (2004) suggested three fundamental affordances for the integration of OER' switch the semantic web "1: The capacity for effective information storage and retrieval. 2: The capacity for nonhuman autonomous agents to augment the learning and information retrieval and processing power of human beings. 3: The capacity of the Internet to support, extend and expand communications capabilities of humans in multiple formats across the bounds of time and space".

Jensen (2017) identified that there is a need for educators to explore such pedagogical skills and practices that are associated with semantic web. So, they may get more benefits by utilizing those skills in a technological environment. Most of the time the educational resources are developed with the aim to facilitate virtual learning as a complete package which is commercially developed to gain profit. On the other hand, many non-profit organizations also produce such kind of systems to support the community collectively by taking such kind of initiatives.

The major issue that lies in the integration of such resources is they lack cohesiveness because different systems are based on different standards. Due to this the reusability and sharing of data for collective purposes is difficult that require a set of skills to resolve such kind of problems to integrate the systems with other systems (Mayernik et al., 2016). Warraich and Rorissa (2018) suggested library expert can provide technical assistance in the process of integration of OERs this support can be provided by the central libraries of the institutions that will help them to provide more state-of-the-art facilities to their users by the library platform.

## **1.2 Statement of the Problem**

In technological advancements paradigm teaching is supported and integrated with the use of different interactive resources such as videos, blackboards and virtually available platforms and with the integration of multimedia resources in formal and informal education. These resources are developed commercially and non-commercially by different institutions. The underlying need is to use and interlink available data in educational domain which will not only enrich educators, students and lifelong learners experiences and skills but also the quality of education will be improved through the implementation of this technology in educational sector. This approach can be implemented in educational domain by following the principles of linked open data that will integrate available data from number of open source available repositories on a single point. So, there is a need to explore that how linked data technology can be implemented in educational sector to use open educational resources (OERs) more effectively by the users. It helps to analyse the benefits, challenges and issues that are associated with the integration of OERs through linked open data. This also explores that does any kind of OERs project locally exists or not.

### **1.3 Research Questions**

The objective of this study is to highlight the nature of LD and OERs and their associated benefits and barriers for educational sector that are connected to the adoption of LD technologies in OERs. These research questions directed the study in the context of integration of OERs with LD technologies.

**RQ1:** What are the benefits for educational sector to adopt LD technologies with OERs?

**RQ2:** Which kind of technical barriers can be involved in adopting LD technologies with OERs?

**RQ3:** Does any kind of locally built OERs projects exists or not?

### **1.4 Methodology**

This paper is based on literature research methodology. Lin (2009) defined literature research methodology as “to read through, analyse and sort literatures in order to identify the essential attribute of materials. Its significant difference from other methodologies is that it does not directly deal with the object under study, but to indirectly access to information from a variety of literatures, which is generally referred to as "non-contact method."

The national and international literature about the integration of OERs through linked open data technologies was searched. Different available databases and scholarly journals were consulted to fulfil the purposes of the study. The search terms for the literature search were ‘linked data and open educational resources, semantic web and open educational resources, E-learning integration through linked open data, linked data opportunities for educational sector, issues for educational sector and integration barriers of linked open data’. Literature published after 2012 to 2019 was critically analysed to

be included in the study. Those studies were preferred that specifically focused on OERs or open e-learning repositories integration through linked open data technologies.

## **1.6 Literature Analysis**

Linked data retains potential benefits for educational sector to adopt this technology for the sharing and publishing of its OERs over the web according to the uniformed standards. IEEE (2014) special editorial advocates that the use of linked data technology in OERs projects will give more integrated and interoperable cohesive systems for publishing, sharing, linking, discovering of resources based on metadata OERs sources. OERs accessibility and integration via linked data also holds some technical barriers for educational sector that are highlighted by different research studies.

### ***1.6.1 Nature of Open Educational Resources (OERs)***

In educational sector the concept of open data is comparatively new area of research after the emergence of rapid internet technologies globally. In education it can be considered as a subgroup of OERs in which datasets are provided for the purpose of learning and teaching. Guy (2016) expressed that open educational data can be used majorly for two purposes:

- (1) “all openly available data that could be used for educational purpose
- (2) open data that is released by education institutions”

In recent years, the focus towards the OERs has grown tremendously as worldwide universities, organizations, public and private initiatives are working on it or using each other data for a common cause of education. OERs can be divided into different categories in accordance with the e.g. Scope, type of repository, provider, content etc. Navarrete and Luján-Mora (2015) categorized OERs in two types such as:



## **1. Resources type categorization:**

It includes Open Courseware (OCW) which are basically provided by the universities which includes e.g. textbook, lecture notes, assignments/quizzes samples, audios and videos etc. Content Creation Initiatives provide collaborative environment for the creation of resources. Subject-Specific OCW OERs focuses on subject based provision of resources such as health, engineering, technology etc. On the other hand, OERs repositories and websites offers educational resources from many providers on a single place and the content is based on multiple formats and covers the larger scope.

## **2. Repository type categorization:**

It is based on three type's websites as:

Type A. OERs websites access content from local repositories

Type B. Which provide access to content from external heterogeneous repositories

Type C. These are hybrid type repositories that provide access to local and external repositories.

The major purpose of this categorization was to have deep and clear understanding of OERs and its underlying infrastructure and its associated issues and searching process. These categorizations clearly define the coverage, content and types which helps to understand OERs.

To adopt LD technologies in OERs its information must be structured. Different metadata standards are available that structured the information in a manner that describes the resource perfectly. The search ability and discoverability of OERs depends to standardized metadata descriptive tags of OERs, which help the web crawler to find resources more accurately (Hillman, 2005). In learning repositories some widely used metadata standards are:

- (1) IEEE Learning Object Metadata (IEEE LOM) is based on 9 categories which also contains subsets to explain the information tags in repositories (IEEE, 2009).
- (2) Dublin Core Metadata Initiative (DCMI), it is widely used metadata standard for digital resources and most commonly use in libraries. It provides 15 elements set for the detail description of data.
- (3) Learning Resource Metadata Initiative (LRMI) is extension of Schema.org. Which is used for the tagging of online content that supports the creation of structured data based on shared vocabularies available via search engines e.g. Google, yahoo etc. (DCMI, 2018).
- (4) OERs discoverability and search process is not an easy task. OERs is based on different internal and external repositories which use different standards according to their needs. In this scenario, the searching process of OERs effects that makes information retrial more complicated the use of faceted and advanced search in OERs websites makes data retrieval more efficient (Navarrete & Luján-Mora, 2015).

The usage of metadata standards not only structured the data but also resolves the issues of interoperability and discoverability of OERs. It makes resources discoverable more easily according to the content or nature and makes the implication of LD technologies in OERs more effective.

### ***1.6.2 Nature of Linked Data***

Linked Data (LD) is based on basic principles that is required for connecting and publishing of structured data and open data over the web that is understandable by the both humans and machines (Chamizo-Gonzalez et al., 2015; Nelson et al., 2014; Dietze et.al, 2012). For the publishing of structured open data over the web Berners-Lee and Swick (2006) introduced a set of rules. The rules were as;

- (1) “Use URIs as names for things.
- (2) Use HTTP URIs so that people can look up those names.
- (3) When someone looks up a URI, provide useful information, using the standards (RDF, SPARQL).
- (4) Include links to other URIs, so that they can discover more things”.

For the publishing of structured data of different disciplines these LD four rules have been proven as an effective guideline. In learning and teaching methodologies the use of technology is increasing day by day. A great number of resources are now available over the web under the open license so others can use it by implementing this technology.

The creator of linked data Berners-Lee (2006) also proposed five-star deployment schema which clearly describes that how data can be published in a specific progressive way. This five-star deployment schema is for open data. Figure 1 shows the level for the deployment of LD.

★	Available on the web (whatever format) but with an open license.
★★	Available as machine-readable structured data (e.g. excel instead of image scan of a table)
★★★	As above plus: Use non-proprietary format (e.g. CSV instead of excel)
★★★★	All the above plus: Use open standards from W3C (RDF and SPARQL) to identify things.
★★★★★	All the above, plus: Link your data to other people’s data to provide context

*Figure 1. Linked Data Five Star Deployment Schema*

In OERs, this deployment schema can be used because OERs are also following its major rules under the sharing of open license. Since the use of LD is increasing now OERs initiatives are also using it. The most popular structured vocabulary in OERs projects is Dublin core metadata schema. In (2015) Navarrete and Luján-Mora defined four rules of Berners-Lee for OERs as;

- (1) “Use URIs as names for OER as unique identifiers, e.g. URI for: OER creator, OER knowledge areas, OER audience level, OER primary format, and other descriptors.
- (2) Using URI, the corresponding OER can be found through URL (by dereference).
- (3) When someone looks up a URI that identifies OER provides integration with other OER.
- (4) OER should be enriched by including relations with others OER”.

### ***1.6.3 Benefits of LD for OERs***

The amount of data in educational sector is increasing rapidly. A massive amount of data is produced by the private and public organizations, institutions and individuals with aim of sharing and reusing of published datasets for their needs. Linked Data provides several advantages for educational data and pedagogical styles in educational sector. Zablith (2016) suggested that having LD for OERs offers three major benefits for educational sector.

- Firstly, LD would be able to provide portability and reuse of data with an ease for OERs in a local context.
- Secondly, the extraction and consumption through LD would be easier for OERs.
- Lastly, the growing number of LD tools would be able to support the publishing and sharing of OERs in an efficient and effective way. Because this trend is also engaging non-profit organizations which will strengthen this technology.

The primary objective of LD usage in educational sector is to facilitate teaching and its learning process through the adoption of new technologies and methodologies in the sharing and publishing of information to massively. Guy (2016) elucidated that the main benefits of using OERs are;

- (1) This will enable common citizens to use information without any barrier or to be involved in policy making and decision making by having information at hands.
- (2) It will provide more ways of engagement and participation in a collaborative and resource sharing environment to common people.
- (3) It retains huge potential for teachers, students, public and private organizations and above all for policy makers.

Bizer, Heath, Berners-Lee (2008) mentioned that as the amount of data link is increasing tremendously the use of LD technology will improve its quality. Because LD uses automated interlinking of data links based on graph-matching.

#### ***1.6.4 LD Integration Challenges for OERs***

As the amount of OERs projects is growing over the web all the OERs are not following uniform standards the issue of discoverability and integration exists. One of the major challenges towards the use and reuse of open data is search ability of relevant resources for usage and this is not as easy as it seems. Because different institutions/individuals use various formats for the creation of data. Dietze et.al (2013) identified four basic challenges to ensure web-scale interoperability of OERs. These challenges are as;

- (1) Heterogeneous educational repositories and integration: Most of the OERs are based on heterogeneous APIs/Service environment so the web-scalability of these resources is challenging in integration process.
- (2) Change in web environment: Due to technology obsolete and change in web environment services various OERs repositories become useless that is also barrier in integration of these OERs.
- (3) Transformation and metadata standards: To integrate data with each other the transformation of data is necessary in many cases of OERs that transformation and standardization is not an easy task.

(4) Interlinking and Enrichment of unstructured metadata: freely available content is most of the time is unstructured that miss links in the process of machine processing of integration. So, the enrichment or modification of unstructured data is also challenging to attain the interoperability of OERs.

All these challenges reflect that the interlinking of OERs in LD has its own limitations for integration process. These challenges can be overcome by following the principles of LD or metadata standardization for newly initiated projects OERs.

The use and integration of OERs also retain certain barriers geographically in case of specialized OER repositories. Firstly, the privacy and protection of data is also challenging in the usage of useful datasets in OERs. Because some useful but controversial data maybe remain unavailable in some continents. Secondly, the cost of releasing OERs or open data sets is expensive, so such kind of projects are not easy to start. Thirdly, the quality of data is suspicious in many freely available resources (Guy, 2016; Raza, Mahmood, & Warraich, 2019).

#### ***1.6.5 Current Status of OERs Linked Data Indigenous Projects***

OERs projects are initiated by the educational institutions such as universities, colleges or schools. On the other side, on a large scale governmental and NGO's initiatives are also common which publish OERs under open license over the web for a great cause of massive learning (Navarrete & Luján-Mora, 2015).

In order to cope with the changing of learning and pedagogical style here in Pakistan, OERs projects are also being initiated by the government or educational institutions on a large scale. The project e-learn Punjab (<https://elearn.punjab.gov.pk/index.html>) was started on 6, January, 2014 with the aim "To seek innovative solutions that can help improving student learning outcomes for

public school students” (PITB, 2018). The purpose of this project was to improve educational system of public schools that would be able to provide backbone to secondary and higher secondary education in Pakistan. It offers free and interactive online access to students not only to e-textbooks but also to more than 1,700 videos, 360 simulations, 470 animations, and assessments via web (*The Express Tribune, January 7<sup>th</sup>, 2014*).

Recently Punjab government has launched another project with the name of e-library Punjab (<https://elibrary.punjab.gov.pk/>) which aims to inculcate e-learning and e-reading culture, exchange of ideas, to give opportunities to general public for networking, open access to online resources through a single point. The Punjab Information Technology Board (PITB) data centre gives access to more than fifty thousand e-books e-theses, documentaries, audios, videos, e-newspaper local and international, data sets, journals etc. through a user-friendly interface. It also provides access to Nobel Laureates presentations, Cambridge Companions and Oxford Reference Online (*The Express Tribune, March 4<sup>th</sup>, 2018*).

A project Pakistan Data Portal (PDP) (<http://data.org.pk/frontend/web/site/index>) aims to provide an online tool for dissemination and sharing of Nutrition and educational datasets. With the purpose to build an environment to usage data for evidence and policymaking. It is based on the principles of linked data technology. Which provides a pool of multiple source-based data related to multiple themes (PDP, 2018). Malik (2013) reported that Virtual University of Pakistan (VUP) started OERs project for the first time in Pakistan with the aim to provide free access to educational resources but they did not release it that time due to some technical barriers and make it available after some years.

These projects evident that OERs has established its roots in Pakistan from last two decades approximately now the new projects are also opting new trends of

technology like linked data to strengthen further OERs initiatives. The use of technological innovations in educational sector will not only provide bundle of learning opportunities without any barrier to students, teachers and life-long learners but also strengthen educational sector too. Many other resources are also evolving rapidly or with the hope in coming years more OERs Linked data gateways and portals are expected to become the part of this streamline.

### **1.7 Conclusion**

The integration of OERs by using the LD technology is getting popularity in educational sector like other fields. The question is how to fully get benefits form OERs, here LD principles come into action to help about the issues of standardization and interoperability. The interlinking of educational content is not only important for students it equally retains potential benefits for teachers too. It provides number of freely available resources with the aim of sharing and reusing of data. The implementation of LD in OERs will make the discoverability and reusability of OERs more efficient that will also provide more refine and enrich resources for education.

A developing country like Pakistan can get the maximum benefits of this technology as the implementation of OERs and other projects is in its infancy stages as elearn and elibrary Punjab. OERs are important to make young generation a life-long learner who can equip with the latest occupational skills. These new projects of OERs have been initiated formally and non-formally that will help to uplift the education in Pakistan. The development of these projects according to international standards will not only able to share resources with others but also the data reusing will be easier. So, the need of hour is to predict the future and use these technologies in educational sector. Linked Data is the key to overcome the problem of interoperability and standardization in OERs integration.



## Availability of data and material

Literature review data is available for necessary.

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