Proof of Concept (PoC) of key features of OER infrastructure

Roadmap towards building the POC of key features of OER infrastructure
D3.1 Proof of Concept (PoC) of key features of OER infrastructure

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Abstract

ENCORE+ responds to the priorities of opening up and modernising the European education and training sector through a coordinated European OER ecosystem. OER (open educational resources) are "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" (UNESCO).

ENCORE+ brings together meaningful and focused human networks; technological solutions for sharing and discovering OER; policy reviews; quality criteria; and generating business models which draw on the affordances of OER to support innovation. ENCORE+ supports uptake of OER through business and academia by formulating value propositions for OER usage for education, training and business.

This is a draft of the first work package 3 deliverable, which is a proof of concept of key features of a OER infrastructure. The document is designed to serve also as a reference document for other developments in Work Package 3, in particular deliverables D3.2: Cutting Edge Technology Showcase for European OER, D3.3: Innovation success features for OER Repositories, and D3.4: H5P OER Content Hub.

1. Introduction

The main objectives of 3. 1 are to map and describe the features and goals of OER providers in the case studies, to identify and explore features used to gather insight intelligence to strengthen innovation, and to explore features in user-driven production chains that produce high learning impact.

The work of Fondazione Politecnico Milano, UNIR and K4A in this task is to investigate and identify success criteria for a robust, sustainable and quality assured OER repository. As described in the project proposal, the investigation has taken into account not only EU examples, but also the selection criterion of usage and community penetration, examining various existing repositories that have been able to evolve over time, such as Merlot, OER Metafinder, Nanohub, OASIS, OERCommons, Skills Commons. This initial list of repositories was examined and relevant repositories were added based on geographic representation of other globally relevant repositories. Desk research was also taken into account.
1. Document overview

The work on the elaboration of the PoC was divided into these subtasks:

- Identify the main objectives of the PoC.
- Identify the relevant descriptors (selection criteria) for the investigation of the technologies.
- Draw up the list of technologies to be evaluated
- Evaluation of the technologies (infrastructures)
- Drafting of the PoC

In Section 1 of this roadmap, we provide insight into the analysis of existing technologies and identify the key features and repositories to be investigated.

In Section 2, we provide an overview of emerging technologies and issues that hinder technological developments.

In Section 3, we focus more on emerging technologies and possible scenarios for how they can enable the increased use of OERs.

In Section 4, we discuss a proposal for a new OER infrastructure by also analysing existing technologies within consortia.

In Section 5, we summarise our main findings with a proposal for building the new OER infrastructure.

The methodology is based on the literature review and synthesis, the assessment of the integration scenarios of the existing technologies in the consortia that could be a starting point for the proposal for the new OER ecosystem, with the aim of further identifying key technologies based on interactions and discussions with the identified stakeholders, and will be intensively discussed in future issues of the Technology Circles. Based on these interactions and discussions, features will be added to the PoC.

2. Existing technologies analysis

In order to contribute to the design of the next generation of Learning Objects Repositories (LOR) it is undoubtedly necessary to analyze what has happened in recent years with LOR, with the user experience in LOR and with the impact of this kind of tools on educational settings. An in-depth analysis of the state of the art can give us valuable information to design new strategies to address the user needs and develop a new ecosystem compatible with the fourth industrial revolution (4.0). Such analysis was
carried out in Encore+ by selecting 20 scientific papers from the Web of Science repository published in relevant journals in order to examine the quality of LOR. The process and results of the literature review are presented in the next sections.

2.1 Overview of the selected papers

Figure 1 shows the word cloud of the topics covered by the selected papers. Words as Learning repositories, quality, metadata, objects, resources, intimately linked to research on LOR emerge naturally.

![Figure 1. Word cloud in the selected literature](image)

2.2 Most used LOR in the literature

Learning Objects Repositories (LOR) have been extensively used in education to support open practices. Especially, teachers share educational content with several purposes, to gain visualisation of their work, to contribute with quality content to other teachers or institutions, as a hobby or due to philosophical reasons as the beliefs of the knowledge should be open to all citizenships.

Whatever the reason for using the LOR, the educational content in the repositories grows accelerated. Content that varies regarding quality, topics, type or simply due from the countries they come from. Table 1 presents a resume of the most commonly used or mentioned LOR as emerging from our literature review.
## 2.2.1 Repositories in Literature

<table>
<thead>
<tr>
<th>Name/Acronym</th>
<th>Short description (taken in most cases from the websites or the articles mentioned)</th>
<th>URL(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGORA</td>
<td>Ágora Repositorio de Recursos Educativos FCE UdeC</td>
<td><a href="https://portal.ucol.mx/agora/">https://portal.ucol.mx/agora/</a></td>
</tr>
<tr>
<td>Ariadne</td>
<td>Learning objects interoperability: The ARIADNE experience (article)</td>
<td><a href="https://www.researchgate.net/publication/221331065_Learning_objects_interoperability_The_ARIADNE_experience">https://www.researchgate.net/publication/221331065_Learning_objects_interoperability_The_ARIADNE_experience</a></td>
</tr>
</tbody>
</table>
| OpenStax on Cnx | Discover learning materials in an Open Space.  
Aimed to view and share free educational material that can be organized as books or other academic assignments. | https://cnx.org (CNX is retiring. Textbooks by OpenStax will always be available at openstax.org. Community-created content will remain viewable until August 2022, and then be moved to Internet Archive). |
| DOOR         | DOOR Digital Open Object Repository is an Open Source piece of software for creating learning objects repositories.  
With DOOR you can store digital content in the form of learning objects (LO), i.e., content + metadata, in a tree-shape catalog. You can then search for LOs, retrieve them and include them in your courses or instructional units. | http://door.sourceforge.net/ |
| ELENA        | Unlocking Open Educational Resources (OERs) Interaction Data                     | https://www.researchgate.net/publication/288025191_Unlocking_Open_Educational_Resources_OERs_Interaction_Data |
| eLera        | Teachers Need Simple, Effective Tools To Evaluate Learningobjects: Enter eLera.Net (article) | eLera.net (now it does not exist anymore)  
Info can be found on: https://www.academia.edu/577593/Teachers_need_simple_effective_tools_to_evaluate_learning_objects_Enter_eLera_net |
<table>
<thead>
<tr>
<th>Organization</th>
<th>Description</th>
<th>URL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europeana</td>
<td>Europeana empowers the cultural heritage sector in its digital transformation. We develop expertise, tools and policies to embrace digital change and encourage partnerships that foster innovation.</td>
<td><a href="https://www.europeana.eu">https://www.europeana.eu</a></td>
</tr>
<tr>
<td>FROAC</td>
<td>Federación de Repositorios de Objetos de Aprendizaje Colombia</td>
<td><a href="http://froac.manizales.unal.edu.co/froac/">http://froac.manizales.unal.edu.co/froac/</a></td>
</tr>
<tr>
<td>LRE-MELT</td>
<td>The Learning Resource Exchange Portal</td>
<td><a href="https://lreforschools.eun.org/">https://lreforschools.eun.org/</a> (does not exist anymore) The Learning Resource Exchange and its portal have been discontinued. Access to the LRE’s collections of metadata is possible for organizations in the education domain upon request. Inquiries should be directed to <a href="mailto:elena.shulman@eun.org">elena.shulman@eun.org</a>.</td>
</tr>
<tr>
<td>Merlot</td>
<td>Merlot (Multimedia Educational Resource for Learning and Online Teaching)</td>
<td><a href="http://merlot.org">http://merlot.org</a></td>
</tr>
<tr>
<td>OERCommons</td>
<td>OER Commons is a public digital library of open educational resources. Explore, create,</td>
<td><a href="https://www.oercommons.org">https://www.oercommons.org</a></td>
</tr>
</tbody>
</table>
and collaborate with educators around the world to improve curriculum.

<table>
<thead>
<tr>
<th>PROLEARN</th>
<th>Fostering children’s learning process &amp; cognitive abilities through holistic approach &amp; innovative methods</th>
<th><a href="https://prolearn-project.eu/">https://prolearn-project.eu/</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>ViSH</td>
<td>ViSH is a social and collaborative platform focused on the creation and sharing of open educational resources</td>
<td><a href="http://vishub.org">http://vishub.org</a></td>
</tr>
<tr>
<td>Wikimedia Commons</td>
<td>Wikimedia Commons is a media file repository making available public domain and freely licensed educational media content (images, sound and video clips) to everyone, in their own language.</td>
<td><a href="https://commons.wikimedia.org">https://commons.wikimedia.org</a></td>
</tr>
<tr>
<td>Wisc-online</td>
<td>Wisc-Online is a repository of high-quality educational learning materials FREE to learners and educators.</td>
<td><a href="https://www.wisc-online.com/">https://www.wisc-online.com/</a></td>
</tr>
<tr>
<td></td>
<td>Wisc-Online offers an ever-growing library of learning objects freely available to students and learners at any level, teachers, parents, and anyone else anywhere on the globe.</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Repositories in the literature
The homepage of Pro-Leearn, one of the above-mentioned repositories (still active).

The homepage of ViSH, one of the above-mentioned repositories (still active).
An example of one of the resources on Wisc-Online, one of the above-mentioned repositories (still active).
2.3 Selected LOR to be evaluated in ENCORE +

Out of the literature review, 7 LOR were selected to be analyzed in detail, based on the frequency of references and quotations in the analysed studies and papers.

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merlot (Multimedia Educational Resource for Learning and Online Teaching) (II)</td>
<td>Repository</td>
<td>The MERLOT collection consists of tens of thousands of discipline-specific learning materials, learning exercises, and Content Builder webpages, together with associated comments, and bookmark collections, all intended to enhance the teaching experience of using a learning material.</td>
</tr>
<tr>
<td>OER Commons</td>
<td>Repository</td>
<td>OER Commons is a digital public library and collaboration platform, informed by the organization's pioneering efforts in knowledge management and educational innovation. OER Commons offers a comprehensive infrastructure for curriculum experts and instructors at all levels to identify high-quality OER and collaborate around their adaptation, evaluation, and use to address the needs of teachers and learners.</td>
</tr>
<tr>
<td>Openstax CNX</td>
<td>Open Textbook</td>
<td>View and share free educational material in small modules that can be organized as courses, books, reports or other academic assignment, all content is built in a simple semantic HTML5 format rich with built-in accessibility.</td>
</tr>
<tr>
<td>VISH</td>
<td>Repository</td>
<td>VISH is a social and collaborative site for creating knowledge resources for the realization of educational activities. The central element of the ViSH is the virtual excursion, a sequence of visits (enriched slides or viewgraphs), designed for projection in the classroom. Each excursion is a sequence of well-designed visual compositions (mash-up) of multimedia resources linked from the Internet, from the local ViSH repository or from other federated repositories. The name virtual excursion is a metaphor for an excursion in a virtual world of knowledge resources.</td>
</tr>
<tr>
<td>The Learning Resource Exchange (LRE)</td>
<td>Repository</td>
<td>The Learning Resource Exchange (LRE) from European Schoolnet (EUN) is a service that enables schools to find educational content from many</td>
</tr>
</tbody>
</table>

Although CNX is retiring, considering the fact that openstax.org and its community-created content will be moved to Internet Archive, and that the literature review is based also on the analysis of Openstax, we decided to keep it into this selection.
different countries and providers. It was developed in order to provide Ministries of Education with access to a network of learning content repositories and associated tools that allow them to more easily exchange high quality learning resources that ‘travel well’ and can be used by teachers in different countries.

<table>
<thead>
<tr>
<th>Repository</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIT Open Courseware</td>
<td>Website</td>
<td>MIT OpenCourseWare (OCW) is a web-based publication of virtually all MIT course content. OCW is open and available to the world and is a permanent MIT activity. More than 2400 courses 300 million visitors.</td>
</tr>
<tr>
<td>Wawasan OER Repository</td>
<td>Repository</td>
<td>This repository holds the Wawasan Open University contribution to the wealth of Open Educational Resources (OERs). WOU OER Repository is powered by WEKO, a homegrown repository software developed by the National Institute of Informatics (NII), Japan</td>
</tr>
</tbody>
</table>

The homepage of MERLOT, one of the selected repositories.
Additionally, three LORs were added to complete the list of ten, considering the geographical regions not represented:

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saudi OER Network</td>
<td>Website</td>
<td>National Center for e-Learning (NCeL) has emerged, under the umbrella of the Ministry of Education - SHMS is a National program that aims in enriching the educational content to support education. This program seeks to find a sustainable path to partnership in design, improvement, maintenance, and enhancing the quality of the digital educational content and it will contribute in providing more educational opportunities for those who speak the Arabic language. This would be achieved through partnerships with leading international and Arabic institutions for building digital repository, and localizations of the OER and building high-quality Arabic educational content. This robust tool will let you export your resources in multiple formats including La Referencia Website.</td>
</tr>
<tr>
<td>La Referencia</td>
<td>Website</td>
<td>The Federated Network of Institutional Repositories of Scientific Publications, or simply LA Referencia, is a Latin American network of open access repositories. Through its services, it supports national Open Access strategies in Latin America through a platform with interoperability standards, sharing and giving visibility to the scientific production generated in institutions of higher education and scientific research.</td>
</tr>
<tr>
<td>Commonwealth of Learning’s Open Access</td>
<td>Repository</td>
<td>Oasis is the Commonwealth of Learning’s online institutional repository for learning resources and publications.</td>
</tr>
<tr>
<td>Repository</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.4 Types of LOR evaluations reported in the literature

LOR are assessed using several types of evaluation. In general, evaluation could be Manual, Automatic or Semi-automatic. In Manual evaluation, a human, based on different criteria establishes indicators for different LOR features. Automatic evaluation is carried out by software agents which analyze formal software language (i.e. HTML) to basically identify missing information and in what measure the formal language is well formed to offer a service for all. Between the two approaches mentioned before is the Semi-automatic evaluation that commonly start from an Automatic evaluation which is complement with a Manual evaluation.
Literature also mentions *continuous and periodical evaluation* as the way to carry out the process over the time. Indeed, this is one of the critical point in LOR maintenance that should be consider for future LOR ecosystems.

**2.5 User Feedback**

LOR normally provides an interface to users to evaluate the OER been hosted by them. Commonly, the evaluation can be carried out by users considering criteria defined by the LOR administrator. Criteria such as: the quality of the content, information in the metadata, user experience, expert perceptions, technical information, among others.

Instruments to capture user feedback about different LOR features have been also created and validated. These instruments measure criteria of evaluation. Some of those instruments are: Metadata quality assurance certification process (MQACP), System Usability Scale (SUS) TUP model, UNE 71362, WBLT-S and WBLT-T, some User satisfaction questionnaire, Web content accessibility guidelines (WCAG), among others.

**2.5.1. User Feedback analysis**

LOR frequently provides feedback analysis to users using quality dashboards which show a consolidated evaluation from the OER features according to users’ opinions. More sophisticated analysis is often provided to administrators.

**3. Literature review on Criteria for success**

The analysis of 17 scientific articles published between 2016 and 2021 offers a good overview about the most cited topics linked to criteria for the success of OER repositories.

Among the most cited, interoperability and quality appear as the centerpiece and we’ll dedicate more space to them. But the list is quite long, both if the items are presented in positive terms (criteria for success) and as issues (factors affecting the success, problems and open issues).

**Usability**, easy access, user friendly interface represent an important factor for success and in some cases are mentioned as an actual issue. If users will not have a satisfactory experience, the availability of OER will be a limited added value. From one side, some users might have limited practical searching skills, but search engines, on the other side, offer sometimes very limited possibilities: OER retrieval is difficult, metadata are selected manually, the relevance of the resource is not always compliant with users expectations, algorithms are not so effective and the possibility to choose between granular annotations and full texts is not guaranteed.
In a couple of articles these problems are linked with another issue, or we could say a possible start for new solutions: new opportunities for dialogue between developers and users (more often teachers) could help a lot improving the actual repositories. Improved dialogue between developers and teachers might have a positive effect on another actual issue: the learning resources submission process needs more effective ways of classification and it should be easier. Also peer reviewing the resources is a process that can take a long time.

We close this list counting another limit, that might be linked with all the others: the volume of resources available can be not sufficient for the different needs of users. The need for larger repositories brings us to the next step: interoperability.

### 3.1 Literature review on interoperability issues

Interoperability is mentioned as one of the factors for success. The primary need for the user to find what she/he is looking for moves to the consideration that search engines should be able to find resources hosted also outside the repository. For satisfactory results, metadata plays a fundamental role. The presence of distinct relational databases creates heterogeneity. Repositories show a lack of metadata standardization that moves to reduced interoperability. Several resources seem to lack important descriptive metadata: they are not always used by content experts when they upload new resources and search engines often do not use contents to filter the results, as a possible alternative solution. If on the one hand there is a data entry problem that involves the end user, on the other hand there seems to be a lack of a standardized reference system to which the teacher can refer. The quality of the metadata seems to be as important as its correct use.

### 3.2 Literature review on quality issues

The quality of the contents may seem a separate matter compared to other factors previously mentioned, for example of an infrastructural nature. Nevertheless this factor is often related to the others. It is obviously often cited as one of the most important factors for success. The quality of contents, but also their relevance (back to metadata...) based on search engine results are crucial for a satisfactory experience for the users. Connected to metadata, the availability of information that helps teachers and trainers to pre-determine, to some extent, the quality of the resources would be useful.

Somehow linked to the quality of OER resources, other criteria for success mentioned in the articles are the possibility for feedback from teachers (this can probably be linked to the need for dialogue between developers and teachers) and the possibility to get data about the impact on students. Pedagogical quality is another sub-theme, linked for example to the idea of generating OER recommendations, still very scarce.
The quality of the OERs depends also on their usability and accessibility. This is, often, an issue. In any case, OER resources represent support for fragile categories of students. This is a success factor that can’t be forgotten.

### 3.3 Literature review on emerging technologies

Some of the articles also mention possible directions that could help improve OERs use and success. The most cited is the semantic web, in terms of semantic relations to similar learning objects hosted outside repository (interoperability) and of more effective search engines results.

With the increasing number of AI applications, the impact on education is also expected. Open education, especially OER, will benefit from machine learning and AI methods. These can significantly impact the problems around OER and meet the need for a new technological solution or hub. The most commonly cited problems that can be solved by applying AI technology include interoperability, accessibility, discoverability, and language issues. As recognized in the UNESCO Recommendation on the Ethics of Artificial Intelligence, AI will have a profound and dynamic impact on "societies, ecosystems, and human lives, including the human mind, in part because of the new ways in which it influences human thinking, interaction and decision-making, and affects education, human, social and natural sciences, culture, and communication and information."

Through access to free, open educational resources created by universities and colleges and funded primarily by governments in Europe and around the world, and through the use of advanced tools, citizens who cannot find open resources in their native language, who cannot afford or access other educational resources, people with disabilities living in remote areas, and social groups with special characteristics and needs will benefit from the application of AI in education. AI has the potential to ensure widespread access to educational materials (as has been achieved with the X5GON project), which also benefits less well-served communities by reducing the costs of translation, ingestion and personalization, and by making the not-so-visible OER repositories visible. In this way, it promotes equity and inclusion for EU communities by reducing access, language, and convergence barriers that limit them. To this end, the Encore+ consortium explored the technologies available within consortia through internal workshops and by facilitating conversations within communities at circle events focused on defining the requirements for a technology solution, showcasing existing use cases of technologies, and exploring the potential of their use within the new European OER ecosystem. A public survey specifically targeting developers of OER technologies and repositories was also launched to explore perceptions of disruptive technologies, including AI, with a particular focus on the importance of metadata standards.
4. Applicable technologies to enhance the uptake of OERs

The large number of scientific papers studied address numerous problems that hinder the development of OER. To these problems, 16 papers propose innovations to enhance the use of OERs. Most of the innovation proposals concern the solution of interoperability problems, which, according to 2 papers, would lead to a higher uptake of OERs. This is also related to the issue of normalizing the classification of OER, which would support greater interoperability of resources, improve their discoverability, and facilitate the development of technologies for innovative recommender systems.

The other important group of papers (6 papers) relates to analysis as an innovative way to improve the adoption of OER. The authors propose a detailed study of the limitations and opportunities of OER repositories in general, the production of a white paper with an overview of quality issues related to OERs, an analysis of the way metadata is used in the context of OERs, and its impact on discoverability in repositories, an analysis of barriers in the search process for OER and an analysis of the potential of the most prominent artificial intelligence (AI) and machine learning practices (ML) used in educational contexts, with a focus on OER.

4.1 Machine Learning for modelling and deep learning

Machine learning offers numerous opportunities in learning analytics and thus potential for building personalized recommender systems. However, the literature review does not show many explicit references to machine learning in OER. One paper refers to machine learning as a novel approach whose potential needs to be analysed. Papers indicating that analysis is needed to facilitate innovations, necessary for increased adoption of OER, also refer to an overview of machine learning practices (ML) used in educational contexts with a focus on OERs. Centralized repositories should facilitate user experience and practice by integrating "intelligent" support for various aspects of user activity, such as personalization of the learning environment, adaptive instruction, personalized recommendations, and tailored feedback. The role of AI and ML is also mentioned in the context of helping students find appropriate learning materials and providing feedback that can be used for improvement.

4.2 Machine translation and language technologies

The literature review shows that the importance of language for access to OER is recognised. Particularly in the European context, there is a real challenge of multilingualism. The language of search and the language of the resources themselves is a crucial qualitative factor that repositories need to take into account.
Although the number of Massive Open Online Courses (MOOCs) and OERs is increasing, they are usually not offered in multiple languages due to the lack of cost-effective solutions for translating the different objects that compose them. However, current automatic speech recognition (ASR) and machine translation (MT) techniques have reached a level of maturity that offers the possibility of automatic transcription, translation, annotation, and data enrichment of OER data in numerous formats, which has a direct impact on interoperability and access. A study by Atenas and Havemann (2014) listed 10 quality indicators for OER repositories based on a literature review. Among them, multilingual support was listed.

Language technologies are not only mentioned as multilingual support in the context of semantic web. An architecture is proposed to integrate, publish and retrieve ecological data from repositories by using linked data. The data is published as RDF triples, using a relational resource description format mapping language and an application ontology to integrate a common vocabulary and a global view of the generated datasets.

### 4.3 Social network analysis

Social media has become an essential part of human interaction and information delivery, as it contains relevant information ranging from social currents to very specific issues. Technically, it combines a variety of disciplines such as data mining, geospatial and Big Data processing, natural language processing, and automated analysis of images and other media, etc.

Regarding the unsatisfactory user experience when searching for OERs, the authors of the reviewed papers propose an innovative solution in the form of a new platform for digital educational resources that uses social network concepts to create a collective intelligence system to improve and refine search results. On this platform, users can rate the available resources and also publish new resources. These users are assigned a ranking, which is used to determine the relevance of their actions on the platform. Users with a high ranking can publish new content that is considered relevant in the platform, eliminating the need for resources to be evaluated by an expert. Unlike other repositories where the publication of content needs to be approved, on this platform the user has the opportunity to actively contribute with new content. The aspect of quality is also mentioned in these papers, using the ranking to give an indication of the quality of the content.

The main elements of a social network in such an innovative platform would provide features such as following users, liking educational resources, tagging educational resources, rating educational resources, creating collections, and enabling a collaborative ranking feature. Actually, at the time of writing, a new project called Florilege (https://florilege.ls2n.fr/, leaded by the University of Nantes - FR), is going in
similar direction. The authors, who have conducted some experiments, claim that using the collective intelligence that results from the ratings and actions of thousands of users provides educators and students with more appropriate content than a simple general web search. In 3 papers, reference is also made to social networking technology as one of the most important technologies for developing new OER repositories, and the link between these principles and quality issues related to OER.

4.4. Additional emerging technologies

Based on the types of applicable technologies listed in the reports commissioned by UNESCO (eg.: Study on the use and potential of frontier technologies expanding the mainstreaming of OERs), blockchain, virtual reality and augmented reality, and brain-computer interfaces were also on our list of technologies to investigate as part of the literature review.

The results of the literature search show that these technologies were not mentioned in the selected literature as possible solutions to the identified problems.

Blockchain can be considered in the educational solution that provides a way to record and share information with a community, such as educational certificates. Another possible application could be a reward system in the form of tokenized actions so that users can leverage and give to the creators of OER that starts as a reward system and evolves through a governance model that adds value to all types of users (students, teachers, and third parties).

Virtual reality and augmented reality is an interactive, computer-generated experience that takes place in a simulated environment. This immersive environment can be useful in an educational context, but was also not mentioned in the literature reviewed.

The same is true for brain-computer interfaces (BCI), sometimes referred to as neural control interface (NCI), mind-machine interface (MMI), direct neural interface (DNI), or brain-machine interface (BMI). This is a direct communication path between an enhanced or wired brain and an external device.
5. Outcomes of T 3.1 and the proposal of a new OER infrastructure

The literature review shows that the requirements for the new technological infrastructure of OER should answer the most frequently mentioned issues, namely: interoperability, quality, ease of access, user-friendly interface, limitations of search engines in the sense that it is difficult to search for OER, lack of possibility to comment OER, to name the most important ones. In the two circle sessions that preceded the finalisation of this document, questions about linking academia and industry were discussed, with participants answering what should be the most important technological aspects, and their answers (albeit to a limited extent) matching the most frequently mentioned points in the literature review.

In the second Circle Event, the exploration of cutting-edge technologies was examined. The main outcome was to explore the potential application of Artificial Intelligence (AI) in the field of OER, the potential of existing content creation frameworks such as H5P (Joubel) and OER integration frameworks such as X5Gon to design a new paradigm for user interface design (UX) for OER repositories, to ensure maximum effectiveness, ease of use, and simplicity in resource discovery, uploading, previewing, organising, and deploying technologies behind OER including platforms, operating systems, browsers, file managers, and other software applications.

In this proof of concept, we aim to present a wireframe of a pilot project to demonstrate that the requirements identified with the desk research, surveys, and through community events (Technology Circle Events) show that the new infrastructure of OER, when implemented, will meet the needs of users and developers of OER. This POC is
intended to gather feedback and insights from consortium members and will be publically released to solicit feedback from the OER communities around Encore+ and beyond. This proposed infrastructure document will be used to assess the feasibility of a new OER infrastructure that will be further defined in Activities 3.2 (Cutting Edge Technology Showcase for European OER), 3.3. (Innovation success features for OER Repositories), and Task 3.4. (Create and demonstrate the H5P OER Content Hub). This POC will provide Encore consortium members with important user feedback and information about the requirements collected and identified in this work, and identify potential technology barriers or pain points through the two scenarios.

This POC verifies that the planned Work Package 3 actions, if the end result were a technological product, will lead to success. The feasibility of the project is examined through 2 scenarios (described in Section 6) that are intended to provide data to potential investors and decision makers to determine how the project or product idea would be feasible and what impact it would have on strengthening OER in Europe.

6. Scenarios for a new OER infrastructure, wireframes and mock-ups

The partnership in work package 3 consists of 3 technological partners, with technological solutions for OER.

A focus of this collaboration of partners was on:

- The potential application of Artificial Intelligence (AI) in the field of OERs,

- The potential of existing content creation frameworks such as H5P (Joubel) and OER integration frameworks such as X5Gon,

- new paradigms for designing user interfaces (UX) for OER repositories to ensure maximum effectiveness, ease of use, and simplicity in discovering, uploading, previewing, and organising resources, and the implementation of technologies behind OER, including platforms, operating systems, browsers, file managers, and other software applications.

Building on the results of the X5gon project, the investigation of existing technologies also focused on the analysis of the actual usage of OER repositories by webtools. Task leader K4A, provides insight into actual usage through its X5Learn service. At its core, it is an AI engine that aggregates millions of OER content from different websites, cultures and in different languages into one interface based on relevance and personal learning needs.
6.1. Possible scenarios of technology integration

In this section of the roadmap document, we have analysed possible technology integration scenarios that support a new infrastructure OER by enhancing the interconnectivity of the tools and services already developed by the Work Package 3 partners.

The wireframes and mock-ups, in addition to identifying the key features of a new OER infrastructure, are an output of Work Package 3 and consist of:

- the literature review and synthesis presented in this document,
- Features and functionalities to be discovered through interactions and discussions with identified stakeholders, particularly in the Technology circles, features defined through testing and surveys conducted as part of the Encore + activities, and
- The evaluation of possible integration scenarios of the technologies available in the consortia.

6.1.1 Notes on graphic identity

The graphic style of the platform is mostly flat to ease development. Only the search bar and the white frames displaying materials have simple shadows to be more user-friendly. In order to adapt to visually diverse contents and to be more intuitive, the layout is kept quite simple, while the use of rounded angles in the elements and the icons' style conveys a friendly mood.

The orange main color is chosen to increase engagement and alertness. This choice was also made to match the saturation and brightness of existing websites related to H5P and to expand the palette of their homepages, which mainly display blue and purple tones. An accent of dark blue (taken from the Encore+ project palette) is used in icons and graphics, as well as to distinguish the pages reserved to admins (where it is declined in different tints). Other colors include tints of the main orange and are used for most elements including icons and buttons.

Lastly, the typographic palette consists of two sans-serif fonts with high-readability: Ubuntu (for titles of all sizes) and Open Sans (for other text including buttons).

6.1.2 Scenario 1: Minimal invasive embedding

A technical overview provides two options for technology integration between X5Learn, H5P, and Canvas that meet the requirements summarised in Chapter 5.
In this approach, individual repositories of OER have the option of embedding a widget or tool in their user interface that can communicate with the central OER index and make meaningful educational recommendations that may be outside of the current repository. With this approach, a repository can provide users with rich resources that go beyond its own collection, providing a richer learning experience within the repository itself. However, this approach requires more technical skills to embed the tool into another system and has limited capabilities (e.g., recommendations and search). Users might stay in their web space longer, but they might not like the idea of UI changing drastically every time they navigate to a new recommendation. This would affect the user experience.

H5P already has a Canvas plugin, so integration between the two technologies is possible, while X5GON doesn’t ingest H5P content. In turn, there is no X5GON/X5Learn plugin for Canvas, while X5GON has a plugin for Moodle. In this scenario, a similar technological solution (plugin) for Canvas can be developed to realistically connect X5GON and X5Learn playlist-related learning activities with Canvas LMS.

X5Learn can also integrate the H5P player, which offers the interactive content available in X5GON search results and include it in X5Learn so that users can:

1. take their own notes and consume H5P content in X5Learn, 2. embed H5P materials in X5Learn playlists for reuse in creating more OERs.

These integrations could also allow us to track user activity across multiple sites and provide meaningful information about actual usage of OER.
Figure: Minimally invasive embedding approach. A backbone infrastructure to improve user experience through better discoverability.

All OER are discovered and indexed in a central collection: X5GON, while repositories can provide a small area on their interface for users to navigate to different repositories to satisfy their thirst for information.

Example: repository that shows an area on its website where OER is offered by various repositories.

6.1.3 Scenario 2: Umbrella Approach.

This approach brings together all OER from different repositories under one umbrella. The OERs that exist in all repositories are centrally indexed and presented to users through a single UI. This approach helps users have a less chaotic experience that keeps the learner in the same screen aesthetic, standards, and behaviours in the system. Therefore, the learner has less stress when learning to work with one system and manoeuvre through several different repositories. In addition, usage data and other interaction information (which can be far more advanced than individual implementations) can be collected through the central portal and passed to each repository. In this more ambitious approach, X5Learn would allow users to open any OER available in X5Learn in the H5P interface for content creation. This way, users can seamlessly find videos in X5Learn, make them interactive, and republish them with the click of a button.

The centralised platform allows users to search for and discover OER. It provides metadata and other services that enable users to use OERs, create and share collections, and make notes and annotations.
Figure: A centralized platform.

Figure: Example of annotations creation in .pdf.
Figure: Example of annotations in video format.
Welcome!

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tacion ullamcorper suscipit lobortis nisl ut aliquip ex

Type in a keyword...  
Advanced

My Playlists
- Machine Learning
- Artificial Intelligence
- Data mining
- Trigonometry
See more

My Notes
- Note 1
- Note 2
- Note 3
- Note 4
See more

History
- Deep learning is...
- Brain Structure and fun
- Steps to the CNS...
- Autonomic nervous sys...
See more

Featured OERs

Featured OERs

Featured OERs

Featured OERs

Featured OERs

Featured OERs

Latest OERs

Latest OERs

Latest OERs

Latest OERs

Latest OERs

Latest OERs

Figure: Mock-up of the potential homepage.
Figure: Mock-up of the search results of OERs.
Figure: Mock-up of the video player.
Figure: Mock-up of the document viewer.
6.2 Advantages of a centralised OER platform for administrators

Administrators need to understand audiences and traffic patterns and gain insights to better manage content, build relationships with users and OER creators, and attract funding and/or customers.

Another innovative integration approach is to automatically generate simple questions from video/PDF content to create a simple “fill in the blank.” This approach would allow users to send the video and AI-generated questions to create interactive videos using H5P.

The two approaches can be compared to Google Analytics and Google.com, with the former having less of a visual presence in the web interface and collecting statistics in a decentralised manner as users move through the ecosystem, but sending the signals to a central point that aggregates those signals and draws insights from them. The latter is a central interface through which users can discover all the different content and navigate from a central point. Both approaches have their merits and limitations, so both options make sense for the ecosystem.

One technological solution to address the literature review in terms of reuse, interconnectivity, and the application of social network analysis is to explore various other ways to add collaborative/social aspects to X5Learn. This could include features for communicating with other users and targeting teachers (who want to create playlists together) and learners (who want to learn from the same content together) through the use of AI.
Figure: Mock-up of the potential user dashboard.
7. References


Website

For further and updated information about this project please see:
www.encoreproject.eu

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