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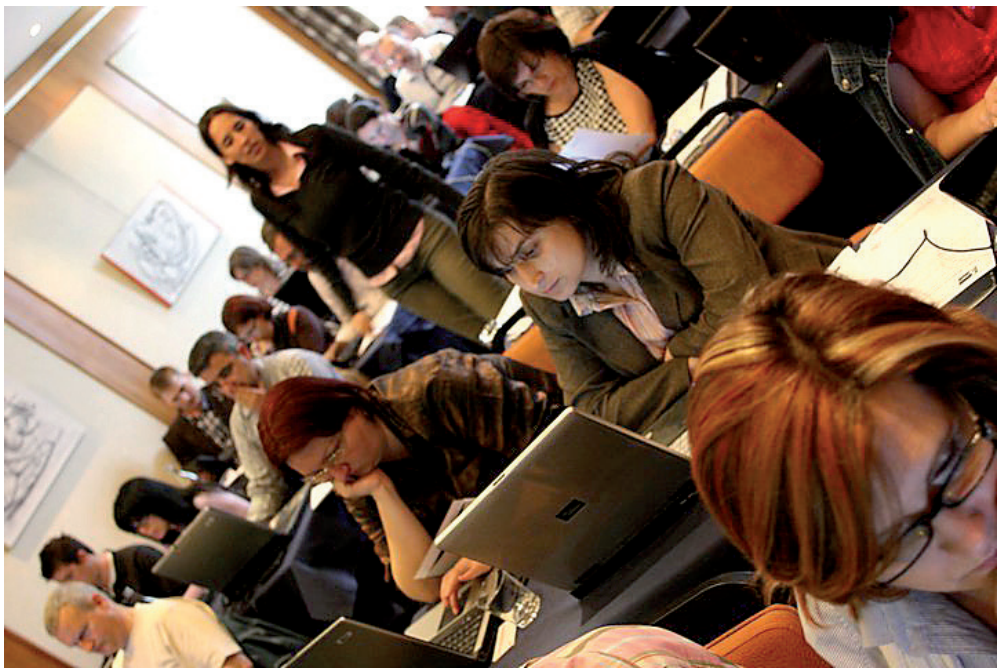
Kati Clements

Why Open Educational Resources Repositories Fail

The Contribution of Quality Approaches to the Success of Repositories



JYVÄSKYLÄN YLIOPISTO

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Esitetään Jyväskylän yliopiston informaatioteknologian tiedekunnan suostumuksella julkisesti tarkastettavaksi yliopiston Agora-rakennuksen Lea Pulkkisen salissa huhtikuun 16. päivänä 2016 kello 12.

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UNIVERSITY OF JYVÄSKYLÄ

JYVÄSKYLÄ 2016

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ABSTRACT

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Over the last two decades, millions of Open Educational Resources (OER) have become freely available for teachers and learners online. These resources are usually accessible through Learning Object Repositories (LORs), which are databases with a user interface. LORs are rarely used to their full potential and often considered as 'failures'. Previous studies have shown that quality has a critical role in the success of information systems such as LORs. However there are no common guidelines for quality assurance approaches for LORs, nor are there studies into the contribution made by different LOR quality assurance approaches to the success of a repository. Measuring quality and success have proven to be a challenge in the research community due to the subjective and dynamic nature of such concepts. To meet this challenge, this thesis studied the perceptions of LOR users and developers with mutiple methodological perspectives. The contribution of this thesis to academic discourse comes from its deepening of the understanding of LOR users' and developers' perceptions on the quality and success of repositories. Frameworks for LOR quality assurance approaches and LOR success metrics were developed in order to identify and design approaches that would augment LOR success, as a theoretical contribution. The findings of these studies show that expert reviews combined with user-generated quality approaches (e.g. recommendation systems, peer reviews, commenting, tagging etc.) contribute towards LOR success. The practical contribution of this thesis is a set of recommendations towards the design of LOR quality approaches. These recommendations have already been used as guidelines for creating quality assurance approaches for four major European LORs.

Keywords: Open Educational Resources, Learning Object Repositories, Quality, Quality assurance, Information systems success

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Jyväskylä 23.12.2015
Kati Clements

FIGURES

TABLES

ABBREVIATIONS

BECTA - British Educational Communications and Technology Agency
CNX – Connexions repository
EFQM - European Foundation for Quality Management
IPR – Intellectual property rights
IS – Information systems
IT – Information technology
ISO – International standardisation organisation
LO – Learning object
LOR – Learning object repository
LORF – Learning object repository, federated
LORSMF – Learning Object Repositories success metrics framework
LORQAF - Learning Object Repositories Quality Assurance Framework
ODS – Open Discovery Space (project)
OSR – Open Science Resources (project)
OER – Open Educational Resource
QAA – Quality assurance approach
TEL – Technology enhanced learning

CONTENTS

LIST OF INCLUDED ARTICLES

I. Clements, K.I., Gras-Velazques, A. and Pawlowski, J.M (2011) Learning Object Repositories Challenging Google – Users Point of View, Published in the Proceedings of International Technology, Education and Development Conference (INTED 2011)

II. Pawlowski, J.M. and Clements, K.I (2010) Implementing Quality Standards for Knowledge-Intensive Organizations, Published in Technology, Instruction, Cognition and Learning, Volume 7, Number 3-4, 2010

III. Clements, K.I. and Pawlowski, J.M.(2012) User-oriented quality for OER: Understanding teachers' views on re-use, quality and trust, Published in Journal of Computer Assisted Learning (JCAL) Volume 28, Issue 1, pages 1-3, February 2012: http://jcal.info/ doi: 10.1111/j.1365-2729.2011.00450.x

IV. Clements, K., Pawlowski, J. and Manouselis, N. (2015) Open Educational Resources Repositories Literature Review – Towards a Comprehensive Quality Approaches Framework, Computers in Human Behavior Vol 51, Part B. October 2015. 2015 (Pages 1098-1106)

V. Clements, K., Pawlowski, J. and Manouselis, N. (2015) How do we measure OER Repositories Success? – a systematic literature review. Published in Proceedings of International Conference on Education and New Learning Technologies (EDULEARN2015)

VI. Clements, K., Pawlowski, J. and Manouselis, N. (2014) Why Open Educational Resources Repositories Fail – Review of Quality Assurance Approaches. Published in Proceedings of International Conference on Education and New Learning Technologies (EDULEARN2014)

Kati Clements was the first author of the papers I, III-VI and did the majority of the work on all those papers. On paper II, Clements completed the data collection and analysis of the empirical section. In all papers, Prof. Jan Pawlowski contributed his advice as a supervisor, paper II is based on his initial ideas and previous works. He also reviewed all intermediate versions of the papers, providing comments and suggestions for improvement. In articles IV-VI, Dr. Nikos Manouselis provided equal supervisor assistance. For the first paper, the empirical section was co-designed and implemented in collaboration with Dr. Agueda Gras-Velazques.

1 INTRODUCTION

In the last two decades, open information resources, including Open Educational Resources (OERs) have become available online (Kanwar et al., 2011) to be used, reused, adapted and shared for learning and teaching (Nikoi and Armelini, 2012). OERs are commonly stored and shared through digital libraries called Learning Object Repositories (LORs) (McGreal, 2008). The purpose of LORs is to be digital libraries that facilitate the storage, retrieval, management, sharing and use of learning objects (Holden, 2003). LORs typically include a database, online user interface and related services for content, quality and community management (Monge et al., 2008; Retalis, 2005). Unfortunately, as the numbers of OERs within LORs keep on growing, many of them struggle not only to get users' attention (Dichev and Dicheva, 2012; Mitchell and Lutters, 2006; Ochoa and Duval, 2009) but also to ensure the quality of the LORs and the OERs within them (Atkins et al., 2007; Downes 2007; Tzikopoulos et al., 2007).

LORs and OERs have been widely researched in the last two decades. Neven and Duval (2002) compared features of repositories, identifying peer reviews as some of the earliest quality assurance instruments. Tzikopoulos et al. (2007) conducted a comprehensive investigation into LORs' characteristics, identifying quality as one of the three main topics. However, they did not look deeper into the contribution of quality assurance approaches towards LOR successes, nor did they examine quality from the point of view of the LOR users. Lack of quality seems to be a critical barrier in LOR use (Pirkkalainen et al., 2014) and high quality content has been identified as a key characteristic of a successful LORs (Ochoa, 2010). Several European Commission-funded projects have published relevant studies on LORs, providing guidelines building successful LORs (Anghrn et al., 2012; Højsholt-Poulsen and Lund, 2008; Sotiriou et al., 2013), underlining low quality as one of the main barriers to LOR success.

Studies in Quality of LORs have focused on the quality resources and metadata (Currier et al., 2004; Duval et al., 2002; Hillman et al., 2008; Robertson, 2005; Sicilia et al., 2005). Ochoa and Duval (2006) operationalised the quality parameters for learning object metadata, including completeness, consistency, conformance, currency, readability and linkage metrics. A recent study by

Atenas and Havemann (2014) presented 10 quality indicators for OER repositories based on a literature review, which included featured resources, user evaluation tools, peer review, authorship of resources, use of standardised metadata, multilingual support, inclusion of social media tools, specification of licence and the availability of the original source code. However, when examining the quality of an information system such as an LOR, the quality of the repository system itself and related services should also be studied (Charlesworth et al., 2008). This thesis aims to close this knowledge gap and to identify and classify LOR quality approaches that would cover not only the quality of the information inside the repository (the OERs and metadata), but also the quality of the system and services attached.

Quality is often listed among the recommendations for successful LORs (Højsholt-Poulsen, L., and Lund, T., 2008; McNaught, 2007; Sridharan et a., 2010). Despite of vast numbers of LOR studies, little has been done to find an answer to the question: how quality assurance for repositories contributes towards repositories' success? In order to answer this question, exploratory studies on this phenomenon were conducted.

The concepts of both the quality and success of LORs are highly subjective and dynamic in their nature. They depend on the stakeholder's perspective, which makes it difficult to achieve in-depth knowledge through quantitative measures alone. There is also no consensus in the community to what LOR quality and success actually mean. To grasp the multiple perspectives and complement and confirm the quantitative findings with qualitative data, research was conducted with a mixed method approach (Kaplan and Duchon, 1988). Perceptions on LOR quality and success were explored from the perspective of two key stakeholder groups: the users and the developers (See Figure 1).

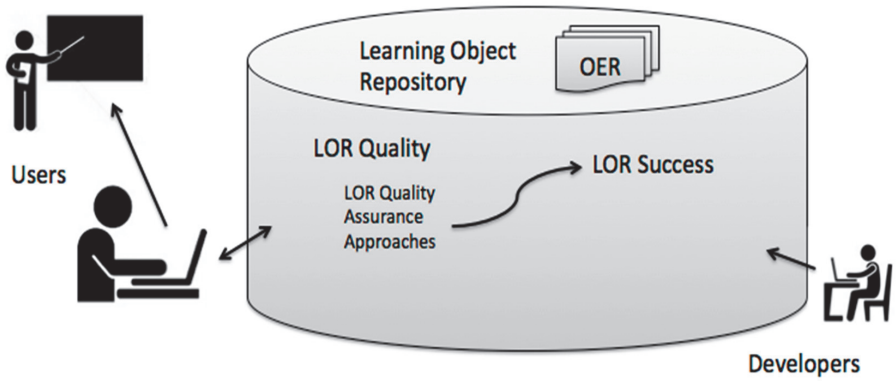

Figure 1: LOR Quality assurance contribution to LOR success.

Given the lack of studies of stakeholder perspectives on the quality and success of LORs, this study identifies and classifies quality approaches. Moreover, it examines the contributions of different quality approaches towards the success of LORs. Based on these findings, recommendations are made for repository developers designing approaches to quality assurance. These practical contributions have been operationalised in four European Commission-funded projects developing LORs in 2007-2015. These recommendations can assist future developers of LORs in designing and improving quality assurance approaches, and thereby make their LORs more successful.

1.1 Theoretical foundation and research context

This thesis focused on Open Educational Resources and Learning Object Repositories were studied with a particular interest in the quality assurance of LORs and the contribution of quality assurance approaches to LOR success. This chapter defines the main concepts and discusses related studies in the field.

1.1.1 Open Educational Resources

The idea of creating digital online learning resources for reuse has been around since the early 1990s, when it was first used in university settings (Coen and Rosenzweig, 2006). The term "Open Educational Resources" (OERs) was introduced by UNESCO (2002) to facilitate the reuse of teaching and learning resources. It defined an OER as:

> [a] technology-enabled, open provision of educational resources for consultation, use and adaptation by a community of users for non-commercial purposes. (UNESCO, 2002)

A popular definition by Downes (2007) describes an OER through the following parameters: "In the system implemented by Creative Commons (non-profit organization widely thought to be representative of an "open" license) authors may stipulate that use requires attribution, that it be non-commercial, or that the product be shared under the same license." This means that an OER might be free to use, but that modification by the user is dependent on its open licence (Creative Commons, 2009). Davis and al. (2010) described educational resources as sets of resources, which have been assembled and described with the intention that they could be acquired and re-used by others. Thus, the following seems to be the essence of an OER: its purpose is to be reused, without cost. "Open" means that, for the end-user, there should be no technical barriers (such as an undisclosed source code), no price barriers (subscriptions, licensing fees, pay-per-view fees) and as few legal permission barriers as possible (copyright and licensing restrictions) (Hylén, 2006). Harmonising the previous definitions, this study extends an OER definition from Pirkkalainen and Pawlowski (2010) as follows:

> OERs are defined as all digital objects that can be freely (or according to their open licence) accessed and used for educational purposes.

Educational resources are often also called 'learning objects' (LOs), learning resources, digital resources, digital content, digital objects, digital resources, reusable learning objects, educational objects, educational resources and educational content in the field of Technology-enhanced learning (McGreal, 2004). OERs differ from other educational resources by their freely available nature.

The origins of the open education concept can be seen to have been inspired by the open source software movement of the early 21st century (Wiley, 2006). Before the development of the Web, systems such as Microcosm introduced learning paths through repositories made from suitable collections of learning resources (Hall et al., 1995). Since then, educational domain initiatives have attempted to provide the technology to support the publication and reuse of OERs (Davis et al., 2010), e.g. to provide access to universities and schools in countries that are still developing their educational approaches. A significant milestone in OER history was MIT's OpenCourseWare Initiative (Albelson, 2008), in which many courses were made freely available. Following MIT's example, many institutions have pursued a policy of giving out course materials for free and instead selling assessment and credentials upon completion, in the form of diplomas or graduation certificates, creating new business models around OERs (Downes, 2007). OERs certainly have been accepted in the community, and educational organisations such as universities have been creating their own collections of OERs. The vast number of OERs now available supposedly leads to greater choice, but also increases likely barriers for OER reuse (Pirkkalainen and Pawlowski, 2014), including possible lack of quality (Tzikopoulos et al., 2007).

OERs are meant to be adaptable, changed, re-mixed and reused within a variety of formats (Hylen, 2006), and are often stored and organised in Learning Object Repositories. Many LORs accept user-generated content, which increases the need for monitoring the quality of the collections (Retalis, 2004). Compared to LORs with commercial content, OER repositories suffer from quality diversity due to the various authors and versions of the OERs (Atkins et al., 2007). OERs are also often created by non-professional authors (e.g. teachers that are not paid extra to create them) increasing the need for quality management. Hence, this study focuses on the quality assurance of repositories containing OERs instead of commercial content. Such repositories are still not used as much as they could be (Ochoa and Duval, 2009). Even though there have been various studies regarding OERs and LORs before (Hatala et al., 2004; Neven and Duval, 2002; Tzikopoulos et al., 2007), many of them have focused on technical aspects of the repositories.

1.1.2 Learning Object Repositories

OERs are commonly stored and shared through Learning Object Repositories (LORs) (McGreal, 2008). LORs are not simply a storage and delivery space for educational resources, but also enable OER reuse and sharing (Duncan, 2002). LORs are multi-functional platforms designed to facilitate access to reusable learning objects in a variety of formats, so users can search for, find and use such content (Downes, 2001). Teachers are the main user group for LORs, however other groups such as learners or parents may also use LORs (Sotiriou et al., 2013). Kahn and Wilensky (2006) define a repository as a "network-accessible storage system in which digital objects may be stored for possible subsequent access or retrieval. The repository has mechanisms for adding new digital objects to its collection (depositing) and for making them available (accessing), using, at a minimum, the repository access protocol. The repository may contain other related information, services, and management systems". This study utilises the Learning Object Repositories definition from McGreal, (2011), stating that they are:

> Digital databases with online user interfaces, that house OER[s], applications and tools.

OERs might be texts, articles, videos, audio recordings, simulations or multimedia applications freely available for users with an open licence. The tools attached could be, for example, resource sharing tools, collaborative working tools, community features or other services to assist re-use and adaptation of OERs. LORs allow OER administration in terms of updating, identifying, utilising, sharing and re-using them (Retalis, 2005). Some popular examples of LORs include: Le Mill [1], MERLOTII[2], OER Commons [3], Connexions – CNX[4], and KlasCement.[5] In the context of this dissertation, Learning Object Repositories are sometimes called: 'educational libraries and open educational resources repositories.'

LOR research has often focused on the features or technical characteristics of the repositories: In the early stages of LOR history, Neven and Duval (2002) compared features from 10 repositories, including metadata schemes, organisations, numbers of learning objects etc., including quality assurance features such as peer reviews and metadata validation schemes. Interestingly, many of these repositories have since ceased operation, however those which had quality assurance approaches in place in 2002 still operate in 2015. McGreal (2008) classified Learning Object Repositories into various typologies. The basic types presented were:

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[1] http://lemill.net/
[2] https://www.merlot.org/merlot/index.htm
[3] https://www.oercommons.org/
[4] https://cnx.org/
[5] https://www.klascement.net/

1. A centralised model with content stored on the site
2. Portals that store links and metadata to materials provided for others
3. Repositories with equal role as a content provider and portal

Depending on whether LORs allow users to create their own content (types 1 and 2), creators need to consider different strategies for assuring the quality not only of the content within the LOR but the content creation and storage processes (Pawlowski, 2007). McGreal's (2008) study has been widely used, as it identifies the principal functionalities of LORs as:

1. search/browse OER
2. view OER
3. download OER
4. store OER
5. download OER's metadata

Quality assurance might be visible to users, particularly in features 1-2, as users' perception of high quality LORs seems to focus on usability and accessibility issues, which means locating OERs that would fit their purposes of locating objects within as little time as possible (Heradio et al., 2012). Tzikopoulos et al., (2007) studied the general characteristics of 59 well-known LORs, covering such issues as subject areas, metadata standards, available languages, evaluation mechanisms, IPR and quality control. They concluded that quality can be assured through user-generated instruments such as peer reviews, commenting and annotations and that majority of repositories claim to follow quality policies (for example guidelines for submission of resources to their collections).

A critical masses of content was achieved by harvesting smaller repositories into massive federated LORs (Ternier et al., 2005). Ochoa and Duval (2009) carried out a quantitative analysis of such LORs' growth, focusing on the number of learning objects and user base growth over time. According to their analysis, most LORs grow only linearly and fail to create the users' desired critical mass of content. However, two years later, a more detailed study of the Connexions repository (later known as "CNX") suggested at least one exception to the rule, as it was clearly growing exponentially in both users and contributions (Ochoa, 2010). A recent study by Zervas et al., (2014) analysed 49 LORs and listed the percentages of those repositories containing quality assurance instruments such as rating/commenting (59%), bookmarking (47%), validation (47%), social tagging (27%) and automatic recommendations (14%). Based on Zervas et al., (2014), the core features in 2014 remain searching, browsing, viewing metadata and downloading learning objects, which match the 2008 findings of McGreal.

New trends in LORs have focused on providing community fostering services within the LOR interfaces (Monge et al., 2008). One of the challenges in LOR research is that various LOR functionality studies (like Neven and Duval, 2002; Tzikopoulos et al., 2007 or Zervas et al., 2014) provide useful snapshots of

LOR functionalities at certain times, but as with all digital resources, they quickly become out of date (Sinclair et al., 2013). LOR life-cycles end and new ones are born all the time, which is why it is important to study the success and sustainability of the repositories themselves (Downes, 2007).

Several studies (McGreal, 2008; Ochoa and Duval, 2009; Ochoa, 2010; Tzikopoulos et al., 2007; Zervas et al., 2014) on LORs have analysed LOR features which assist quality assurance, however there is little knowledge on how quality assurance approaches and instruments actually contribute towards an LOR's success. Previous to this study, there has also been no guideline or recommendation on how to design LOR quality approaches. Particularly since many repositories struggle to establish user communities and stay alive in the fast-growing competition for educational resources market, high-quality OERs may have a competitive advantage. Athenas and Havemann, (2014) have listed possible approaches to assuring the quality of LORs however previous to this study, contributions of quality assurance approaches towards LOR success have not been examined. Understanding this relationship is important in aiding the design of quality assurance approaches that can facilitate the success of LORs.

1.1.3 Learning Object Repositories Quality

Historically, the best-known quote on the nature of quality is usually attributed to the English writer John Ruskin (1819-1900): "Quality is never an accident; it is always the result of intelligent effort." The origin of the word quality in Latin derives from "*qualis*", meaning "of what kind'" (Fields, 1993). This nuance of quality targets the inherent characteristics of a product or a supply of services. According to International Organisation for Standardisation, quality is defined as a "totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs." (ISO 9000, 2014). Quality is often defined as "fitness for purpose" in literature, implying a need to consider the perspective of the consumers of the products examined (Juran and Gryna, 1980; Juran, 1989). Quality in data can be defined as "data that are fit for use by data consumers" (Strong et al., 1997). There is no universal definition of quality – it varies with the stakeholders and context (Evans, 2004; Ehlers and Pawlowski, 2006). Quality depends on the alignment between the user constituency being served, the context where deployed, and the intended purpose (Bethard et al., 2009). "Transcendent" quality means that the underlining concept cannot be defined, that it depends on the quality actor's perceptions, experience and emotions (Garvin, 1984). The subjective and dynamic nature of quality makes it difficult to measure (Sinclair et al., 2013; Vargo et al., 2003). Whereas a user might define the quality of an OER as "fitness for his/her purpose," a developer of the same LOR might see quality as "conformance to specification." In the commercial world, the product view of quality ties it to the inherent characteristics of the product. On the other hand, a value-based view regards quality as dependent on the amount a customer is willing to pay for it (Kitchenhamn and Pfleeger, 1996).

Previous studies of quality from a user's perspective have been on a rather abstract level (Currier et al., 2004; Leacock and Nesbit, 2007; Ochoa and Duval,

2006). There is a lack of studies of LOR quality from the point of view of the users which could give in-depth understanding and contribute towards practical guidelines on how to design LOR quality assurance approaches. Delone and McLean's IS Success Model (1992; 2003; 2004) suggests three levels of quality leading to success of an information system (see Table 1) such as LORs.

Table 1: Contextualisation of LOR quality derived from Delone and McLean (1992; 2003;2004) IS Success Model

Information systems	Learning object repository contextualisation
Information quality	Open Educational Resources quality, (e.g. data quality or metadata quality, depending on the types of LORs)
System quality	Repository quality (e.g. interface, interoperability, policies etc.)
Service quality	Services attached to the repository quality (e.g. community building services quality, recommender systems quality etc.)

The need for the existence of processes that ensure information (data) quality has previously been studied in the case of digital repositories (Barton et al. 2003; Cechinel et al. 2011; Stvillia et al. 2004; Tate and Hoshek, 2009). However, none of these studies offered practical guidelines for designing LOR quality assurance approaches that would contribute towards an LOR's success. When assuring quality for LORs, it is important to look at not just the data quality assurance but also the quality of the repository itself (system quality, service quality etc.) (Charlesworth et al., 2008). While earlier works have focused on the quality of the data, very little research has been conducted into the system and service quality of LORs. One example is that LORs have various quality policies and approaches (Tzikopoulos et al., 2007), but there is no consensus in the community on what LOR quality approaches are and how to classify them. Classifying quality approaches would help developers to design comprehensive quality assurance approaches which would take into consideration aspects of information, system and service quality of an LOR.

1.1.4 Quality assurance for LORs

In the context of LOR quality assurance, this study examines quality approaches and instruments that might help achieve information quality, system quality and service quality. LORs typically have significant problems with data or metadata quality (Palavitsinis, 2014; Pérez-Mateo et al., 2011) such as missing fields, broken links, lack of preview pictures etc. As learning objects can differ in several aspects (size, granularity, technology used, type, metadata standard, instructional design, duration, etc.) (Churchill, 2007), it is reasonable to assume that the quality criteria and the ways of measurement will depend upon and also differ accordingly to these many aspects (Cechinel et al., 2011). However, it is important to recognise

that when quality-assuring an information system like Learning Object Repositories, one should also check the system and service quality (Charlesworth, 2008). This is often done by setting up quality standards or policies (Pawlowski, 2007). According to Tzikopoulos et al., (2007), about 66% of LORs studied had a quality policy for submitting learning objects to their collections, 43% provided support for users to select resources and many offered user-generated quality instruments such as rankings, commenting or annotations.

Studies on LORs (Atenas and Havemann, 2014; Manouselis and Costopoulou, 2006; Petrides et al., 2008) have highlighted the issue of quality assurance for repositories, as this is seen as the key to provision of quality content to end users. This thesis explores general approaches such as standards and policies for LOR quality assurance, extending the data quality management perspective at the level of system and service quality assurance. In the following section, quality approaches and instruments for assuring Learning Object Repositories are presented.

1.1.4.1 Quality approaches for LORs

Generic quality approaches such as ISO 9000 standards contain domain-independent criteria and can generally lead to trust in certified organisations (ISO, 2014). According to Pawlowski (2007), around 26% of knowledge-intensive organisations with LORs (Ministries of Education, Universities etc.) use generic approaches such as ISO 9000. Generic quality approaches are accepted by the community due to their wide popularity, and organisations' willingness to certify and promote quality, both internally and externally. These provide a consistent minimum quality of LORs. If, for example, an organisation uses the European Foundation for Quality Management (EFQM) excellence model (Osseo-Asare and Longbottom, 2002), it is assured that all products have been assessed and quality controlled. However, generic quality approaches are quite abstract for stakeholders such as the users or developers of LORs. They provide little in the ways of practical tools for quality assurance of LORs. Therefore, it is important to contextualise quality assurance approaches to provide practical guidance for LOR developers. In the context of this research, specific quality approaches for technology-enhanced learning are defined as the following key approaches adapted from Pawlowski (2007):

- *Quality marks for education* assure the quality of organisations and/or products and services by certification (Pawlowski, 2007)

- *Benchmarking*. Comparing the practises and outcomes of an organisation against its purposes or industry "best practices". (Atkins et al., 2007; Balagué and Saarti, 2009; Billings et al., 2001; Wilson and Town, 2006)

- *Content development criteria and guidelines* listing best practices provided for the content providers of the LORs. (Babalhavaeji et al., 2010; Boskic, 2003; Defude and Farhat, 2005; Drachsler et al., 2014; Højsholt-Poulsen,

L., and Lund, T, 2008; Kurilovas, 2009; Leacock and Nesbit, 2007; Sinclair et al, 2013; Vargo et al., 2003; Westbrook et al., 2012)

- *Experts reviewing the content* ensuring that all content is pre-evaluated by experts before publishing (Atkins et al., 2007; Catteau et al, 2008; Kurilovas, 2009; Missier et al., 2006; Nesbit and Li, 2004), e.g. against content development guidelines or criteria.

These approaches aim at achieving a heightened quality of LORs. Specific quality approaches are typically appointed and managed by the LOR developer, but often approved by a community/council of experts reviewing the approach. A good example of a specific quality approach can be found in the guidelines for the now-defunct British Educational Communications and Technology Agency, or BECTA, which contained the following quality principles for LORs (Højsholt-Poulsen, L., and Lund, T, 2008):

- Robustness and support,
- interoperability,
- inclusion and access,
- learner engagement,
- innovative approaches,
- ease of use and
- testing and verification,
- effective communication.

BECTA also encouraged repository owners to have a clear quality strategy in place. Its data quality principles included: digital learning resource design, human-computer interaction, quality of assets, accessibility, matches to the curriculum, effective learning, assessment to support learning and robust summative asessment (Charlesworth et al., 2008). However, quality approach principles such as BECTA's (Charlesworth et al., 2008) often remain at an abstract level, which leaves freedom for implementation. Consequently, quality approaches should be accompanied by quality instruments., which are further outlined in the next chapter.

Quality approaches cover highly abstract standards and specifications such as ISO 9000 (ISO, 2014), as well as more specific technology-enhanced, learning domain-related approaches such as quality marks, benchmarking, and expert reviews against guidelines or criteria. Earlier research has examined generic and specific quality approaches, but there has not previously been a quality approach classification, nor is there a clear recommendation on how to implement quality assurance approaches. Quality approach classification is needed to assemble current approaches into a framework which could be utilized in LOR development when selecting different levels of quality approaches for the repository.

1.1.4.2 Quality instruments for LORs

Quality instruments are defined as tools and practices which allow quality assurance to be performed (Camilleri et al., 2014). For example, LOR developers might set technical features within the repository that allow the community to contribute either directly through rating, reviewing, commenting, flagging, tagging etc. (Venturi and Bessis, 2006; Waaijers and van der Graaf, 2011), or indirectly through an LOR portal that can monitor the users' activities and use social data to make automatic promotions of content, such as recommendation systems (Li, 2010; Manouselis et al, 2011; Sanz-Rodríguez et al., 2010). As OER repositories need sustainable solutions for quality assurance (Downes, 2007), specific quality instruments have become increasingly popular. Unfortunately, in voluntary settings such as OER communities, it is not easy to find adequately motivated reviewers. Specific quality instruments can only work with a strong community behind them (Davis et al., 2010). LOR developers favour specific quality instruments because they are cost-effective, meaning that in most cases they can be operated either automatically by the system or manually through community involvement, therefore saving the expense of hiring an expert to review the content. In the following section, specific quality instruments rising from literature are described:

- *Peer reviews* (Catteau et al, 2008; Currier et al., 2004; Krauss and Ally, 2005; Li, 2010; Liddy et al., 2002; Sampson and Zervas, 2013; Sanz-Rodríguez et al., 2010; Venturi and Bessis, 2006; Waaijers and van der Graaf, 2011; Zervas et al., 2014;) mean that users *can* give "star ratings" on a Likert scale or "likes." Some repositories provide a full template for a more extensive method of peer reviewing. Such ratings have often been a subject of debate concerning whether they reveal any useful information about the resource. Ochoa (2010) noted that the clearly successful Connexions LOR had only had 0.1% of its content rated in any way. In contrast, Merlot's rate and review covers more than 25% of its materials (Ochoa and Duval., 2008)

- *Evaluation tools* are usually evaluation forms in the user interface of the LOR, such as the Learning Object Review Instrument (LORI) Evaluation Criteria (Belfer, et al., 2002) :

    1. Content Quality: veracity, accuracy, balanced presentation of ideas, and appropriate level of detail.

    2. Learning Goal Alignment: alignment among learning goals, activities, assessments, and learner characteristics.

    3. Feedback and Adaptation: adaptive content or feedback driven by differential learner input or learner modeling.

    4. Motivation: ability to motivate, and stimulate the interest of an identified population of learners.

5. Presentation Design: design of visual and auditory information for enhanced learning and efficient mental processing.

6. Interaction Usability: ease of navigation, predictability of the user interface, and the quality of the user interface help features.

7. Reusability: ability to port between different courses or learning contexts without modification.

8. Value of accompanying instructor guide: ability of resource to enhance instructional methodology

- *Recommendation systems* suggest OERs to the users based on their previous activities in the LOR portal (Adomavicius and Tuzhilin 2005; Atenas and Havemann, 2014; Duffin and Muramatsu, 2008; Li, 2010; Manouselis et al, 2011; Manouselis et al, 2013; Manouselis and Sampson 2004; Pegler, 2013; Petrides et al., 2008; Sampson and Zervas, 2013; Sanz-Rodríguez et al., 2010; Zervas et al., 2014)

- *Commenting* allows users to leave open comments in the OER (Catteau et al, 2008; Li, 2010; Minguillon et al., 2009; Sampson and Zervas, 2013; Sanz-Rodríguez et al., 2010; Vargo et al., 2003; Waaijers and van der Graaf, 2011)

- *Favourites* allows users to add resources to their own collections (Minguillon et al., 2009; Sampson and Zervas, 2013; Sanz-Rodríguez et al., 2010; Zervas et al., 2014)

- *Social tagging* means that users can either invent their own keywords to the resources or select them from a predetermined list (Minguillon et al., 2009; Sampson and Zervas, 2013; Stacey, 2007)

- *Subscriptions* allow users to follow interesting resources or people in the LOR interface (Minguillon et al., 2009; Sampson and Zervas, 2013; Zervas et al., 2014)

- *Flagging* allows users to report incorrect or bad quality resources. The most common cases are resources with broken links (Sinclair et al., 2013;)

- *Trusted networks-approach* means that the LOR states its quality policy relies on trusted organisations or individuals creating the OER without checking the content. This is an especially popular approach among federated repositories as they have too much content for expert reviewers to check (Davis et al., 2010; Pawlowski and Clements., 2013).

- *Automated quality instruments* identified and computed metrics for 16 quality indicators (e.g., cognitive authority, resource currency, cost, and adver-

tising) and employed machine-learning techniques to classify resources into different quality bands based on these indicators. These findings were further used by Bethard et al. (2009), who confirmed the feasibility of deconstructing the concept of quality for educational resources into smaller pieces of measurable dimensions, opening the way for the automated characterisation of quality of resources inside educational digital libraries. The authors were able to identify five quality indicators which could be automatically observed and measured inside learning resources through the use of natural language processing and machine learning techniques (Defude and Farhat, 2005; Kurilovas, 2009; Liddy et al., 2002; Palavitsinis et al., 2013; Strong et al., 1997; Stvilia et al., 2004)

Studies since that of Neven and Duval (2002) have identified user-generated quality instruments for LORs. Even though many LORs have user-generated quality instruments in place, their contribution towards success of the LOR have not been studied. This dissertation focuses on identification and classification of user-generated quality instruments, as well as exploring their contribution towards LOR success. This topic is particularly important because LORs often suffer from a lack of sustainable business models (Downes, 2007), and user-generated quality instruments offer a more cost effective solution for quality as long as the community behind the LOR is active (Ochoa, 2010).

1.1.5 Learning Object Repositories success

The *Oxford English Dictionary* offers an etymology for "success" from the 16th century, simply as "the accomplishment of an aim or purpose." A judgement of "success" can be dependent on the perspective of whoever sets the aim, as well as who assesses whether the purpose was accomplished (Freeman and Beale, 1992). Definitions of success often vary by the perspective of the stakeholder or unit (user, developer, funder, surrounding organisation etc.)(Larsen et al., 2009). Myers (1995) and Wilson and Howcroft (2002) suggest that success is achieved when an information system such as an LOR is *perceived* to be successful by stakeholders. However, given the human tendency to underestimate challenges and overestimate their own capabilities, stakeholders might regard a project as a partial failure even if it were "successful" in achieving near-optimal results (Thomas and Fernández, 2008). No repository can be said to be truly successful in a meaningful sense unless it fulfils its purpose (Thibodeau, 2007). Re-use is the reason for existence of many Learning Object Repositories (Ochoa, 2011). Therefore when evaluating LOR success, the level of re-use of the OER should be a factor.

Quality and success are usually linked (Charlesworth et al., 2008). The Information Systems Success Model by Delone and McLean (1992, 2002, 2003) suggests that information quality, system quality and service quality lead to success in an information system such as a learning object repository (Rai et al., 2002; Seddon, 1997; Seddon et al., 1999). Ochoa (2010) and Højsholt-Poulsen, L., and Lund, T (2008) identified the quality of LORs to be a critical factor leading to LOR success.

It is not news that software projects for information systems often fail and Learning Object Repositories are no exception (Dichev and Dicheva, 2012; Mitchell and Lutters, 2006; Ochoa and Duval, 2009). The success of LORs has been studied focusing on success factors or success criteria (Lund and al., 2010; McNaught, 2007; Nash, 2005; Polsani, 2006; Tzikopoulos and al. 2007). Monge et al. (2008) suggested strategies such as "clear authorship, rapid content creation, indexable content for search engines, social tagging and social recommendation systems" for improving user involvement in repositories. Lund et al., (2010) listed recommendations for LOR owners such as: "community creation support and stategy, engaging users as early as possible, utilisation of open standards, interoperability with other repositories and LMSs, sustainable business modelling, brand building, keeping it simple, rewarding user activity, developing culture of sharing, easy-to-find quality content." Nash (2005) also recommended the utilisation of standards, engaging users early, clear licencing, recommendations for re-use and re-mixing of content, use of approperiate granularity and using various delivery modes (online, blended, mobile, video games etc.).

According to Højsholt-Poulsen and Lund (2008), user-based repositories seem to have greater success than most traditional top-down approaches in involving teachers and creating an active community. Yeomans (2006) reminds us that even the most mature repositories, such as the physics community's *arXiv*, may generate impressive statistics but offer little to help anyone know what kind of "success" those figures measure. This is due to differences in the perceptions of success among different stakeholder groups, such as users and developers. Definition of LOR success is still debated in the community; specifically there is no consensus on how to measure it. Ochoa (2010) studied the Connexions repository, which experienced exponential growth in contributors and contents compared to others that grow linearly. Similar forces to those that contribute to the success of Wikipedia are also pushing the success of Connexions, and differentiating it from traditional LORs. Key factors behind the success of Connexions (Ochoa, 2010) included content that was high quality, ample, modular, continually updated, personalised on assembly and published on demand, along with site usability and an engaged, involved user community, as well as branding of the LOR.

Ochoa and Duval (2009) quantitatively analysed the size, growth and contributor bases of LORs. Zervas et al. (2014) also examined LOR success metrics such as the number of learning objects and users, as well as the age of the repository, revealing that the adoption level of the LO components' features and added-value services can only marginally affect the LORs' growth. Petter et al. (2008) suggested that measures might need to be different for systems which have voluntary use, such as Learning Object Repositories. To measure the success of digital libraries, Khoo et al. (2008) suggested the following metrics: Visits, Unique Visits, Page Views, and Hits. Vuorikari and Koper (2009) suggested measuring different levels of re-use (the numbers of resources integrated into a new context).

Even though various metrics have been proposed, there is no consensus on how to measure LOR success. Measuring LOR quality studies were explored

in order to provide a comprehensive framework for LOR success metrics. Stakeholder perspectives have been little studied, even though they are key of understaning the success of LORs. Measuring LOR success and understanding stakeholders' perceptions of it can facilitate the design of future repositories, and also future projects that build LORs.

1.2 Research objectives

Despite the vast amount of OERs available through LORs, many of them struggle with their success (Dichev and Dicheva, 2012; Mitchell and Lutters, 2006; Ochoa and Duval, 2009). According to several studies (Lund and al., 2010; Ochoa, 2010; Tzikopoulos and al. 2007), quality assurance seems to be a critical success factor for LORs. The main objective of this PhD study is to understand the concepts of quality and success for LORs from the point of view of both users and developers, and the contribution of quality assurance approaches to LOR success. Godwin and McAndrew (2008), Petrides et al. (2008) and Richter and Ehlers (2010) have discussed users' OER behavior in terms of needs and motivations. However, there is also a need to understand users' behaviour regarding LORs, specifially their perceptions on what makes an LOR successful. This led to the first research question, answered in Article I, concerning users' perception of LOR success factors:

- **RQ1: What expectations do users have towards LORs?**

Article I's conclusion, that LOR quality is a key success factor for LORs, is widely supported (Camillieri et al., 2014, Lund and al., 2010; Ochoa, 2010). LOR quality studies have often focused on *data* quality (Atenas and Havemann, 2014; Currier et al., 2004; Palavitsinis, 2014; Petrides et al., 2008), but when assuring *repository* quality, the quality of system and services should also be considered (Charlesworth et al., 2008). The objective of this thesis is to identify and classify LOR quality approaches, which would extend and harmonise existing guidelines, policies and standards for quality assurance, also considering aspects of system and service quality. This led to the second research question, tackled in Articles II and IV:

- **RQ2: What are LOR quality assurance approaches and how can they be classified?**

Since LORs are meant to serve user communities, one of the main considerations is the user's perception (Heradio et al., 2014). Works on digital library quality have concentrated on concepts of perceived usefulness and usability as the key characteristics of quality from the point of view of the users (Tsakonas and Papatheodorou, 2008). User perspectives have most famously been dis-

cussed through the technology acceptance model (Davis and Bagozzi, 1989) which underlines usefulness and ease-of-use as the main facilitators for intention to use technologies. However, in the domain of LORs, there are still few studies of users' perspective on the quality of OERs and LORs, nor are there any guidelines for designing practical quality approaches for users. This led to the third research question, explored in Article III:

- **RQ3: How do users perceive LOR quality?**

Regardless of the amount of educational resources available, many LORs are often seen as unsuccessful (Dichev and Dicheva, 2012; Mitchell and Lutters, 2006). "Success" for LORs has been studied before (e.g. Ochoa and Duval, 2009; Tzikopoulos et al., 2009; Polsani, 2006), but without an apparent consensus on how to achieve or measure it. Definitions of success often vary by the perspective of the stakeholder or unit (user, developer, funder, surrounding organisation etc.) (Larsen et al., 2009), which is why it is relevant to understand both the users' and developers' perspectives on LOR success. Many information systems projects also fail due to a lack of common understanding or expectations between the users and the developers (Tesch et al., 2009), and LORs are no exception (Hanna and Wood, 2011). This led to the fourth research question, answered in Article V:

- **RQ4: How do developers perceive LOR success and how can it be measured?**

Lund and al. (2010), Tzikopoulos and al. (2007) and Ochoa (2010) have identified quality as one of the key success factors for LORs. Various studies have suggested quality assurance approaches (Atenas and Havemann, 2014; Palavitsinis, 2014), but the contribution of LOR quality assurance approaches to LOR success has not been analysed in earlier studies. Based on this identified gap in previous research, this led to the fifth and overall research question of this study, answered in article VI:

- **RQ5: How do LOR quality assurance approaches contribute towards LOR success?**

This research effort was divided into the six articles that comprise this study, addressing these guiding research questions. Figure 2 shows the relationship of the articles to the research process.

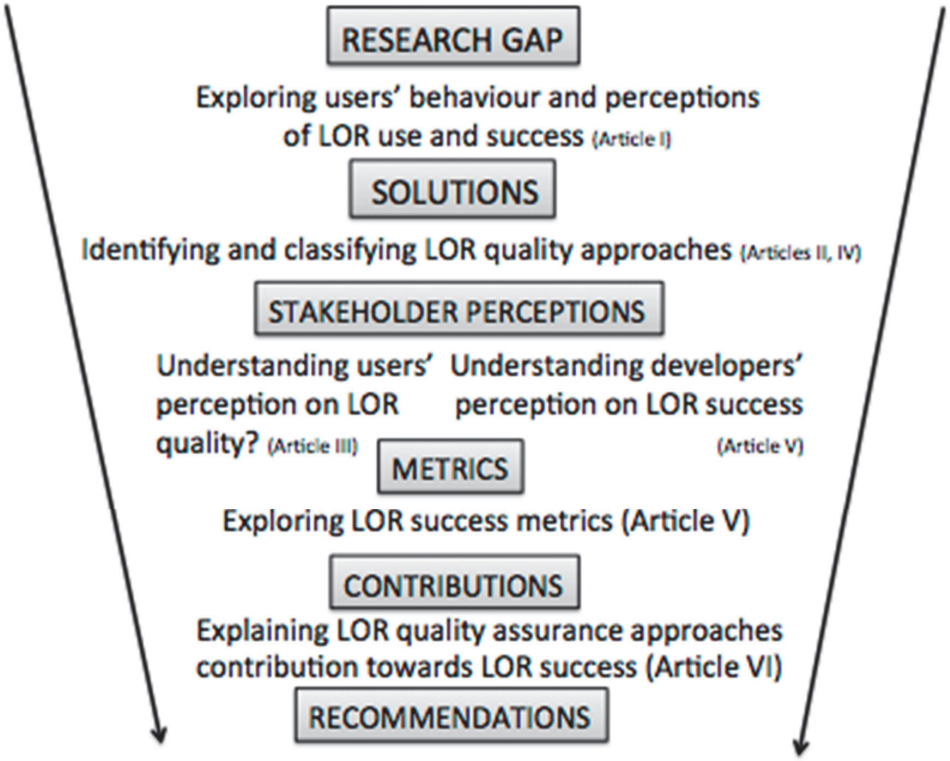

Figure 2: Relationships of the articles included

2 RESEARCH METHODS AND APPROACH

The following section describes the methodological aspects of this thesis, and explains the selected research approach and methods (selection of target group, data collection and data analysis).

2.1 Research design

The aim of this research is to understand the contribution of quality assurance approaches towards LOR success. The relatively young topic allows room for exploration, therefore the aim of this study was to analyse a certain phenomenon (Gregor, 2006). This research followed a mixed method approach (Kaplan and Duchon, 1988), combining quantitative and qualitative studies in order to give enriched perspectives on the phenomenon. Collecting different kinds of data by different methods from different sources provides a wider range of coverage that may result in a fuller picture of the unit under study than would have been achieved otherwise (Bonoma, 1985). The strength of mixed methods research lies in the possibility it presents to understand and explain complex organizational and social phenomena (Venkatesh et al., 2013).

Research questions, objectives, and the research context should be the main driver for selecting a mixed methods approach (Creswell and Clark, 2007; Teddlie and Tashakkori, 2009; Venkatesh at al., 2013). Even though there has been various studies (e.g. Ochoa, 2010; Petrides et al., 2008; Sánchez-Alonso et al., 2007; Sinclair et al., 2013; Zervas et al., 2014) tackling issues related to the success of repositories, the repositories continue to fail. There has not been previous research on the contribution of quality assurance to the success of repositories. This study was exploratory in its nature throughout tacking this objective.

The first aim was to understand users' behavior and expectations. *Why are they not using LORs?* An experiment was chosen as a suitable method to explore the behavior of users in LORs. In order to better understand the users' expecta-

tions for successful LORs, data was gathered with quantitative (survey) and qualitative (interviews) methods for Article I. After an experiment identifying quality as one of the key expectations for successful LORs (Article I), the initial classification of quality approach and the quality adoption model (Article II) were drawn based on literature review. Case study methodology was chosen to illustrate the quality adoption model by applying the approach derived from the literature to a real learning object repository (Yin, 2003).

Users' perceptions of quality were then explored through three surveys and analyzed with descriptive statistics (Article III). Quantitative methodology was chosen to explore three different groups of teachers working around LORs. Systematic literature reviews (Kitchenhamn, 2004) were then used to map quality assurance approaches and the success metrics of LORs (Articles IV and V). Finally, the contribution of quality assurance approaches to LOR success was analysed through interviews with LOR developers in order to also understand their perspective on the phenomenon. In Article VI, quality approaches and success were given a score based on the richness of their quality approach and the level of success. Comparison of these scores revealed that LOR quality assurance approaches contribute towards the success of a repository. Quantitative data was complemented by qualitative data from the interviews for a deeper understanding of the findings. The findings for Article VI could not be appreciated solely through quantitative methodology because of the subjective and dynamic nature of the main concepts of quality and success (Article VI).

Venkatesh et al. (2013) propose that in addition to the validation of quantitative and qualitative studies of the research, the mixed methods should also be validated in terms of research design, meta-inferences and potential threads and remedies, to ensure validation of the research methodology. Different expectations and perceptions of users and developers are often the reason why software projects fail (Tesch et al., 2009), the two critical stakeholder groups of users and developers were studied. Table 2 below summarises the methodological approaches used.

Table 2 Summary of the methodological approaches taken in the articles

	Approach	Collection of evidence	Unit of Analysis (n)	LORs	Analysis method
I	Exploring theoretical knowledge	Experiment: Survey, interviews, observation (n=46)	European teachers(n=46)	LRE	Descriptive statistical analysis, content analysis
II	Creating and illustrating theoretical knowledge	Case study, survey	European teachers (n=36)	COSMOS	Descriptive statistical analysis
III	Exploring and creating theoretical knowledge,	Surveys(n=36, n=80, n=66)	European teachers (n=36, n=80, n=66)	OSR	Descriptive statistical analysis
IV	Creating theoretical knowledge	Systematic Literature review	82 papers from 1994 to 2014	Various	Content analysis
V	Creating theoretical knowledge	Systematic Literature review	20 papers from 2002 to 2014	Various	Content analysis
VI	Exploring theoretical knowledge, creating practical knowledge	Multiple case studies: Interview 35 LOR managers/developers	35 managers/developers (27 Europeans, 1 Northern American, 7 Latin Americans)	27 repositories from Europe and Americas	Content analysis

2.2 Literature reviews

The literature reviews (Articles IV and V) were conducted through the systematic literature approach of Fink (2005), using it as a method to describe available knowledge for professional practice. A rigorous approach should be systematic with clear methodology, explicit in its procedures, comprehensive in its analysis and reproducible by others (Fink, 2005). The literature reviews followed the steps defined by Kitchenham (2004) for conducting a rigorous analysis. These steps are further explained in Table 3.

Table 3: Literature review steps

Literature review steps (Kitchenhamn, 2004)	In this thesis
1) Identify the need and define the method	Aspects of LORs quality approaches and success metrics were identified to have research gaps.
2) Create research question(s),	Research questions for the systematic literature review were motivated by Article I, where users identified quality as one of the main barriers of LOR use: What are the quality assurance approaches in the previous literature? What are the ways to measure LOR success in the previous literature?
3) Conduct a search for relevant literature (Data collection)	Literature review covered the years 1994-2015 of the 10 top journals of the Technology Enhanced Learning (TEL) field according to the Advanced Digital Systems and Services for Education and Learning ranking. Currently the oldest Learning Object Repositories are about 17 years old (Zervas et al., 2014), making this a reasonable period to analyse the studies on them. Articles outside these journals were also included due to their importance to the community and practise in the field. The snowball technique was also used when selected articles cited other relevant articles on the topics. The main criteria for the literature review was to include articles which focused on OER/LORs, specifically from the point of view of quality and/or success of the LOR. Synonyms of OER, LORs, quality and success were also used in order to identify as many studies in the field as possible. This allowed a better overall scope for the approaches, as varied terminology is often used to express the same phenomenon. For all of the key literature, the main entry points were the IEEE Xplore bibliographic database, the ACM Digital Library and Google Scholar.
4) Assess the quality and appropriateness of the studies	All top journal publications are peer reviewed. Conference papers were also included or excluded based on their affect on the community as revealed by their Google Scholar citations. To extend the selected sample, non-peer-reviewed publications (project deliverables) were also included – the field of LORs has been widely researched within projects, providing much valuable information on these issues. These reports and deliverables contain valuable and particularly practical information on the topics, and therefore should not be overlooked merely because of their less "academic" nature. These deliverables have gone through the project's internal review and have a high impact on the practice and community of LORs.

5) Extract data from the studies	Data was extracted into an Excel spreadsheet and Word document to show (1) a numeric overview as well as (2) the specific context of the relevant information for our studies. The researcher also took notes throughout the review process.
6) Interpret the results and write a report	The results were combined into suitable tables and interpreted in the articles.

The synthesis of the literature reviews took a constructive approach (Crnkovic, 2010). Constructive research is suitable for assembling of a solution (artifact or a theory) based on existing knowledge (Crnkovic, 2010). In our case, the approach was to build on existing knowledge of quality approaches and success metrics to construct artifacts into a framework to study quality approaches and success metrics for LORs. Therefore, the conceptual framework was aimed towards theory building (Nunamaker, et al., 1990) by contributing to the body of knowledge with a variety of challenges that require validation in real stakeholder contexts. The constructive element is combined with the approach of Kitchenham (2004) in analysing, synthesising and interpreting the literature in order to finalise the data analysis and construct LOR quality assurance approaches and success metrics frameworks.

2.3 Quantitative studies

2.3.1 Selection of the target group

For Article I, teachers from Romania, Flemish-speaking Belgium, Lithuania and Portugal were selected – 1 specialist teacher from each territory, and ten general teachers from each territory (n=46 teachers). A wide variety of European countries was covered to gain a representative sample of European teachers. This is called maximum variation sampling (Miles and Huberman, 1994). The teachers selected were mathematics, science and/or technology teachers with some experience with ICT and Learning Resources, currently teaching 6- to 21-year-old students. Up to 80% of the teachers had advanced ICT skills and previous experience with resources, repositories and international projects—an important consideration when analysing the results, since they comprised advanced teachers and did not represent the general teacher population. Consequently, if these teachers found the project tasks and concepts too difficult or uninteresting, one can be reasonably certain that this outlook would apply even more to teachers with average or below-average ICT competence.

In Article II, n=36 teachers were chosen for the survey as the key user group of Learning Object Repositories. These users had a variety of technical skills and most were aware and interested in the quality of resources as well as of organisations.

Teachers answering the surveys in Article III were also ICT/Mathematics teachers from secondary level education (teaching students 15-19 years old). Surveys were used because we intended to gather information on the opinions of this particular population (Tanur 1982; Yu 2003). Surveys also allowed us to determine the values and relations of our key variables (Newsted et al. 1998). These surveys mainly comprised multiple choice questions; however, open questions were also used to obtain further explanations of the answers. The survey questions were validated by pretesting with a small sample of focus teachers (n = 4) before the actual data gathering took place. These teachers were selected by their own interest towards OERs and LORs. The first survey (n = 80) included teachers from Lithuania, Portugal, Finland, Belgium, and Romania. The second survey (n = 66) also included teachers from these countries but additionally from Austria, Sweden, Greece, United Kingdom, Bulgaria, Turkey, and one teacher from Ethiopia. No particular skills of ICT were requested of the teachers. However, the teachers were observed to be more ICT-literate than average teachers in Europe, which should be taken into consideration when assessing these results. According to their responses, 79% of these were using computers for several hours per day, and they were familiar with advanced computer-based teaching such as blogs, wikis, and learning management systems (LMSs). ICT-literate teachers interested in OER can be seen as representative of teachers using repositories, making this responder group relevant for our study.

2.3.2 Data collection

The empirical data for quantitative studies in this thesis was gathered from three different European projects working on Learning Object Repositories:

1. The COSMOS project (2007-2009) was a European project which has developed a repository, tools and templates to improve the (re-)use of Open Educational Resources (OERs) for science education with a particular focus on astronomical resources. (Sotiriou, 2008)
2. The ASPECT project (2008-2011) was a Best Practice Network (BPN) venture supported by the European Commission's eContentplus Programme. It started in September 2008 and involved 22 partners from 15 countries, including nine Ministries of Education (MoE), four commercial content developers and leading technology providers. For the first time, experts from all international standardisation bodies and consortia active in e-learning (CEN/ISSS, IEEE, ISO, IMS, ADL) worked together to improve the adoption of learning technology standards and specifications. (Massart and Shulman, 2011)
3. Open Science Resources (2009-2012) was a collaborative project supported by the European Commission's eContentplus Programme which created a shared repository of scientific digital objects from European science museums and centres, and made them available for the context of formal and informal learning situations. (Sampson et al., 2011)

For Article I, three workshops were organised over a period of one year. During the workshops, teachers had to:

- Fill in questionnaires to obtain background information on the teachers, their attitudes towards resources, sharing of resources and how they worked with them, to enable us to understand the type of teachers we were working with.
- Carry out experiments on discovery and re-use of resources, in order to understand how they searched and interacted with the LORs.
- Contribute their own LOs to the repository.
- Fill in questionnaires with their views on the quality of the OERs and LORs.
- Attend interviews to pass on in-depth knowlegde on their attitudes on the experiment.

For Article II, teachers used the 'COSMOS' repository for a one-week trial period, after which they answered a survey. Some of the teachers had prior experience of the repository.

Article III's data was gathered from teachers who participated in two summer schools organised by the COSMOS and ASPECT projects. The summer schools were chosen as a test bed in order to make sure that all teachers had an understanding of the basic concepts of OERs, LORs, and quality mechanisms. The sample groups can give an indication of the users' views on issues researched, but cannot be generalised for the whole European teacher community since the backgrounds, skills, and interests of the teachers vary greatly within Europe. The survey answers were gathered via digital forms (Dommeyer et al. 2004). The response rate covered the whole sample as these teachers were participating in a specific event, and this could be achieved.

2.3.3 Data analysis

The purpose of all surveys was to explore concepts predefined by literature (Pinsonneault and Kraemer 1993; Yu 2003), which meant that all surveys were analysed with this setting in mind. In all cases, the data was analysed through descriptive statistical analysis. Descriptive analysis gives summaries of the observations made in the data collection. Descriptive statistics are a simple and effective way to present data for various stakeholder groups. Given that this research was embedded in collaboration with users and developers, this descriptive approach was valued by collaboration partners given the practical contributions derived for creating and collaborating in the LOR communities of users and developers.

2.4 Qualitative studies

This research followed a qualitative multiple case study approach (Yin, 2002) in order to gain in-depth understanding of the quality approaches contribution towards the success of Learning Object Repositories (Article VI). The case study followed the guidelines of Eisenhardt (1989). The main part of the case studies comprised interviews with developers of various well-known repositories. This knowledge could not be acquired through quantitative methods because of the complexity of the phenomenon and the need for understanding the stakeholders' perceptions of success as well as quality.

2.4.1 Selection of the target group

For Article VI, 35 managers/developers (27 Europeans, 1 Northern American, 7 Latin American) representing 27 repositories were interviewed. In some cases, more than one person was interviewed for one repository in order to catch both the perspective of managers and those in charge of building the user community. Sometimes the same person took on these roles; sometimes the role was split between two or more. This was due to variant organisations having different types of roles per employee. The same questions were asked of interviewees in both roles. The aim was to insure both points of view. The repositories were selected based on a maximum variation sampling (Patton, 1990); both successful and less successful repositories were included in the sampling, as well as representatives from each of three types of repositories (National, thematic, federated – international) as well as different resource collection sizes, from the Serbian national collection containing a few hundred courses to the ARIADNE federation with over a million resources. Our sampling method aimed to represent different geographical areas. Access to interview partners was by direct contact and snowballing. In the case of Latin America, for example, interviewed experts were asked to recommend other colleagues from their geographical area as potential new interviewees. This can be seen as a snowball technique for sampling (Goodman, 1961).

2.4.2 Data collection

Data collection was undertaken for a one-year period. All interviews were conducted, transcribed, coded and analysed by two researchers to avoid subjective bias. The interviews were conducted either online (70%, via Skype and Flashmeeting) or face-to-face (30%) depending on availability. The duration of the interviews ranged from half an hour to one hour. The analysis of the interviews was done following the Miles and Huberman (1994) guidelines for coding. Additional information was retrieved after the initial interview from 60% of the interviewees. Additional materials (such numbers of content, visible of user-generated quality mechanisms etc.) were also obtained on a case-by-case basis

from the repositories' websites for triangulation purposes; to back up the data gathered in interviews.

2.4.3 Data analysis

All interviews was transcribed and sent back to the interviewees to approve. All data was coded against the quality assurance literature themes and analysed with software (Atlas.ti). The repositories' identity was coded to protect anonymity of the Article VI content analysis, which was selected because of its ability to sort the empirical evidence into categories or themes for drawing meaningful conclusions.

In order to simplify the two approaches of quality approaches and success, a comparable metric criterion was developed for this paper based on both previous metrics and the repositories' reporting of the ways they measured quality and success. This part of the analysis can be described as data-driven. Qualitative data can be presented in a numerical format for clarification, following the examples of presenting evidence used by Sarker and Sarker (2009).

2.5 Summary of methodological approaches taken

This research used a mixed method approach to investigate how quality approaches and instruments can contribute to the success of LORs. Three main types of research methods were used:

1. Systematic literature reviews (Articles VI and V)
2. Quantitative surveys (Articles I-III)
3. Qualitative case studies (Articles II and VI)

The mixed method approach brought a comprehensive understanding to the phenomenon of LOR quality and success from the point of view of the stakeholders as well as the contributions of quality assurance approaches on success of the LORs. Mixed methodology was chosen to both understand the complex phenomenon and also to provide complementary data for the studies at hand.

3 OVERVIEW OF THE INCLUDED ARTICLES

This section describes the key objectives and findings of the six articles included in this thesis. In this chapter, the research objectives, methods and findings are summarised for each article. The relation of these articles to the overall research questions is also discussed.

3.1 Article I: Learning Object Repositories Challenging Google

Clements, K., Gras-Velazquez, A., and Pawlowski, J. (2011). Learning Object Repositories challenging Google – Users' point of view. INTED2011 Proceedings, 627-635.

Research objectives and methods

The first paper examines how repositories can be used beneficially for teachers to find resources for their lessons in comparison to efficient search engines like Google. The motivation behind this article was to study users' behavior in LORs to understand the expectations that users have regarding successful LORs. This is important because the purpose of LORs is to grow active communities using and uploading further content. The study conducted was an experiment using LORs in a laboratory setting. Data collection methods included a survey, interviews and observation of the key user group, teachers: 10-12 teachers from four countries (n=46). Teachers were from Portugal, Belgium, Lithuania and Romania, selected to represent a wide variety of European teachers.

Findings

In this challenging experimental setting of searching for OERs with both LORs and Google, the main results regarding LOR quality were not promising. Even when teachers could find the resources that they were looking for, they were

not impressed with the quality of the resources found. Based on this initial case study, teachers had three requirements for a successful repository:

1. The repository must contain high-quality resources.
2. The repository must be up to date and functional (easy to use)
3. There needs to be a critical mass of content in which to search for resources.

Contribution towards overall research questions

Article I gives an initial results-based answer to the RQ1: *What expectations do users have towards LORs?* The findings of this article support previous works in the field (Ochoa, 2010; Højsholt-Poulsen, L., and Lund, T., 2008), namely that quality is a key success criteria for LORs. This article also laid the groundwork for Article III, for understanding users' perceptions on quality (RQ3).

3.2 Article II: Implementing Quality Standards for Knowledge-Intensive Organizations

Pawlowski, J. M., and Clements, K. I. (2010). Implementing quality standards for knowledge-intensive organizations. Journal of Technology, Instruction, Cognition and Learning (TICL), 7, 295-314.

Research objectives and methods

The aim of this article was to identify and classify quality approaches, focusing specifically on quality standards, and developing a method to adapt quality standards to organisational needs. A case-study method was used to show how quality approaches classification and adaptation of quality standards can work in the context of an Open Educational Resource repository. The approach was evaluated with a study of the key user group, teachers (n=36).

Findings

The main contribution of this paper is its three-part quality assurance approaches classification for LORs:

1. Generic quality approaches
2. Domain-specific quality approaches
3. Specific quality instruments

The initial validation of this classification worked well in the context of the case study performed for this research. In particular, the following quality instruments were found successful:

"*Trusted organizations and individuals*" – approach. This means that organisations and individuals would be considered as trusted (Cummings and Bromiley, 1996, Dirks and Ferrin, 2001). During use, resources from trust organisations or people have a high probability of attaining a certain quality level, which can be additionally assured by regular sample evaluations.

Review processes – trusted resources. For certain resources, reviews are a mechanism by which the user community assures quality. However, not all resources can be reviewed every time they are changed. This would be a mechanism to create trusted resources (cf. Jøsang et al., 2007) which would have a higher reputation.

Rankings and recommendations – swift trust. These semi-automated mechanisms can be used for quality purposes. The idea is to provide recommendations to fulfill the users' quality needs and expectations and to create short-term swift trust (Järvenpää et al., 2004). This mechanism cannot guarantee quality but increases the probability of achieving a certain quality level. Rankings also help to identify low-quality resources.

Users explained that quality is based on how they trust different entities. In our interviews, the following aspects were identified regarding trust:

- 79% of the interviewees trusted materials that came from an organisation with a good reputation.
- 71% trusted resources which had been evaluated by colleagues or scientists in the field.
- 38% trusted materials that had received good rankings.
- 50% looked at the download ratings and how often the resource had been used by others.
- 67% trusted resources that came from an organisation with a quality certificate.
- 50% trusted resources which were interoperable with their own Learning Management Systems.
- 46% trusted the full metadata records attached to a resource.

Contribution towards overall research questions

The article's contribution is towards RQ2: *What are LOR quality assurance approaches and how can they be classified?* The initial quality assurance approaches classification and instruments from this paper are used throughout in papers II-VI; this one can be seen as an initial conceptual paper. However, this article also gave an initial indication towards answering RQ3: *How do users perceive LOR quality?* Studies for Article III built on this initial study of users' perceptions.

3.3 Article III: User-oriented quality for OER: Understanding teachers' views on re-use, quality and trust

Clements, K. I., and Pawlowski, J. M. (2012). User-oriented quality for OER: understanding teachers' views on re-use, quality, and trust. Journal of Computer Assisted Learning, 28(1), 4-14.

Research objectives and methods

The objective of this research was to expore the concept of quality from the perspective of the users. Two surveys with Science, ICT and Math teachers (n=80) (n=66) from countries around Europe were conducted and processed with descriptive statistical analysis for the empirical part of this study. The teachers' initial awareness of quality approaches (Figure 3) showed that most knew about specific quality instruments, but domain-specific and generic quality approaches were not something with which these users were familiar.

Findings

The main findings of this article focused on users' perceptions on quality and quality assurance. Users see quality of LORs differently based on their previous knowledge and competence in using LORs. Based on our findings, LOR quality for users means, for example, that the OERs found from the repository are scientifically correct and fit into the curricula being taught in their classes. Users also appreciated interoperability between other platforms such as LMSs and could recognise quality easily if the OER came from a content provider with a high reputation (e.g. CERN, Harvard, or NASA).

The key findings of this paper indicated that both specific top-down and instrument bottom-up user-generated quality level approaches are needed for maximising the cost-effectiveness of the approach. Obviously, generic standards quality approaches do not seem to be something to which users pay any attention. It is vital to remember that user-generated quality assurance instruments can only make repositories successful if the community around the repository is strong enough to support them. Based on our findings, the success of LORs in most cases requires expert reviews for all content. However, overall, the most effective single approach seems to be peer review of the content. These research findings benefit developers and managers of LORs regarding choices in their quality assurance approaches.

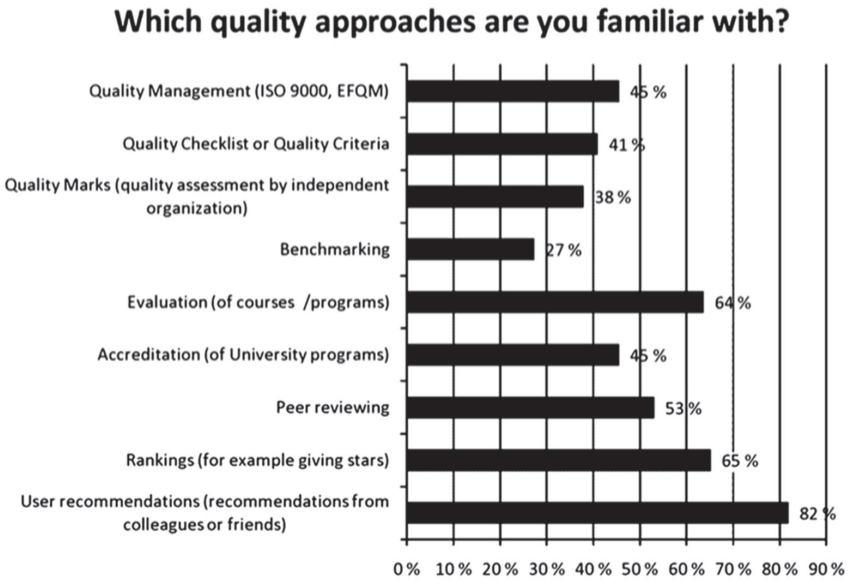

Figure 3: Users' quality approaches familiarity

Contribution towards overall research questions

Article III answers the research question RQ3: *How do users percieve LOR quality?* This article also contributes towards understanding users' views on successful LORs and QAAs influencing LOR success. Insights from the article were further investigated in article VI.

3.4 Article IV: Open Educational Resources Repositories Literature Review - Towards a Comprehensive Quality Approaches Framework

Clements, K., Pawlowski, J. and Manouselis, N. (2015) Open Educational Resources Repositories Literature Review - Towards a Comprehensive Quality Approaches Framework, Computers in Human Behavior Vol 51B. October 2015., p.1098-1106

Research objectives and methods

Previous studies have shown that quality assurance of LORs is a significant factor when predicting the success of a repository. Within the study, technology-enhanced learning literature was systematically analysed regarding LORs' quality approaches and specific collaborative instruments. Previous research has been focusing on quality assurance for learning objects or their metadata (Pala-

vitsinis, 2014), however when assuring quality of an information system such as LOR, it is also important to look at quality of the system itself and the services around it. This literature review aimed at identifying and classifying quality approaches from previous studies. This article's theoretical contribution is a comprehensive framework of LOR quality approaches (See Figure 6) that demonstrates and classifies a wide spectrum of possible approaches from standards to user-generated quality instruments such as recommendation systems, peer reviews, commenting etc. The purpose of this article was to assist LOR developers in designing sustainable quality assurance approaches fully utilising the potential of collaborative quality assurance tools.

Findings

The main contribution of this article is the Learning Object Repositories Quality Assurance Framework (LORQAF – see Figure 6). The LORQAF takes into consideration the learning objects lifecycle, categorising the quality assurance approaches into pre- and post-publication phases. Moreover, it reflects on the responsible "quality actor or stakeholder" by categorising quality assurance into developers' quality choices, technology, automated quality, expert-reviewed quality and user-generated quality.

Most cited quality approaches in previous research have been "peer reviews" and "recommendation systems." These user-generated, collaborative, quality instruments are favoured for their sustainable nature. However, user-generated quality assurance approaches can only work when the community around the LOR is strong enough. Expert reviews were recognised as a powerful tool to assure LORs quality.

Contribution towards overall research questions

Article IV took the results from Articles I-III and developed further the classification of LOR quality assurance approaches. The study addressed the research question RQ2: *What are LOR quality assurance approaches and how can they be classified?* Based on previous literature. This article also set the foundations for Article VI.

3.5 Article V: How do we measure Open Educational Resources Repositories Success? – A systematic literature review

Clements, K., Pawlowski, J., and Manouselis, N. (2014). How do we measure Open Educatuonal Resources Repositories Success – a systematic literature review. In EDULEARN15 Proceedings. 7th International Conference on Education and New Learning Technologies Barcelona, Spain International Association of Technology, Education and Development IATED.

Research objectives and methods

Regardless of the amount of educational resources available, many LORs are often seen as unsuccessful (Dichev and Dicheva, 2012; Mitchell and Lutters, 2006). Consequently, finding models for sustainable collections is a key issue in repository research, and the main problem arising is understanding the evolution of successful repositories (Sánchez-Alonso et al., 2011). Successful LORs have been studied in the past (e.g. Ochoa and Duval, 2009; Polsani, 2006; Tzikopoulos et al., 2007), but there has not been consensus on how to measure the repositories' success. In this research, a comprehensive literature review was conducted into the issue of repository success in the field of technology-enhanced learning. The article classified various metrics proposed by previous literature for successful LORs (Lund and Hojsholt-Poulsen, 2010; Thomas and McDonald, 2007; Venturi and Bessis, 2006) and gives recommendations on how to measure such success. The main success indicators arising from previous literature focused on interactions of users of and contributors to the repository (See Figure 4).

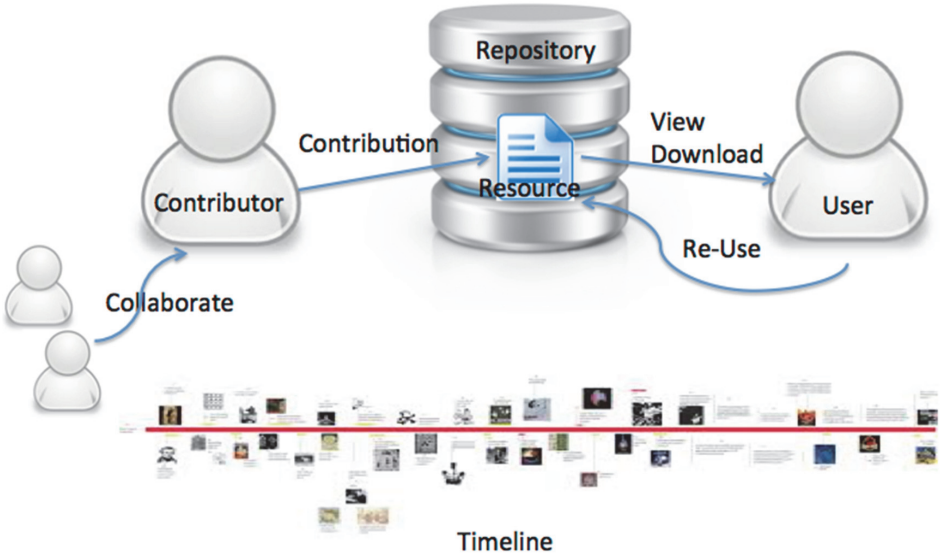

Figure 4 LOR Success metrics

Findings

The main contribution of this article is the LOR success metrics framework (LORSMF – see Table 7) which can provide developers of LORs with guidance on how to quantitatively measure the success of the repository. Findings also indicate that LOR success should be studied with both qualitative and quantitative methods in order to fully understand the phenomenon.

Contribution towards overall research questions

Article V tackles the research question RQ4: *How do developers perceive LOR success and how can it be measured?* Article V grounded the work for article VI to answer the overall question of this thesis in RQ5: *How do LOR quality assurance approaches contribute towards LOR success?*

3.6 Article VI: Why Open Educational Resources Repositories Fail - Review of Quality Assurance Approaches

Clements, K., Pawlowski, J., and Manouselis, N. (2014). Why Open Educational Resources Repositories fail-Review of Quality Assurance Approaches. In EDULEARN14 Proceedings. 6th International Conference on Education and New Learning Technologies Barcelona, Spain (pp. 929-939). International Association of Technology, Education and Development IATED. ISBN 978-84-617-0557-3. International Association of Technology, Education and Development IATED.

Research objectives and methods

The research objective of this paper was to find the contribution of quality assurance approaches to the success of LORs. In this qualitative study, 35 managers/developers from 27 national, thematic and federated LORs were interviewed about LORs' quality approaches and success. The key findings of this study show that a carefully selected quality approach leads to success of the repository in most cases, the key instruments for quality assurance being expert and user-generated quality approaches (such as peer reviews, commenting, recommender systems etc.). This study helps LOR developers to design sustainable quality assurance approaches.

Findings

The main outcome of this paper is a recommendation for combining different types of quality assurance approaches for LORs. This set of recommendations can help LOR developers when they are considering the quality assurance approach of their repository. Based on the findings of the article, LOR Success analysis should, at very least, take into consideration the following metrics: (simplified based on provious literature)

1. *Contribution growth and publishing rate*. Active users after the original funding has ended
2. *Lifetime*. The repository has been successful at receiving funding after the initial project/initiative has ended/has sustainable funding otherwise, such as through a ministry or corporate sponsor

3. *Content life cycle*. OERs or technology which are moved into another repository should also be considered as indicators of success

Quality assurance requires a combined approach of expert review (Specific level) and user-generated activities (Instrumental level). According to our analysis, LOR quality approaches contribute towards LOR success. National portals run by ministries of education seem to be the most sustainable both in their funding background and their quality approach.

Generic quality approaches do not seem to be favoured by the developers any more than users of LORs. Developers see additional value in using repositories as test beds, which is a form of "success" that cannot be measured with the current success metrics proposed by previous literature (Article V). Most developers suggest "user engagement" as a good metric for success of LORs.

Contribution towards overall research questions

Article VI brings together the concepts of the quality, quality assurance and success of LORs, investigated in articles I-V. It answers the last research question RQ5: *How do LOR quality assurance approaches contribute towards LOR success?*

4 CONTRIBUTIONS

This section discusses the key contributions of this thesis from both theoretical and practical perspectives. The contributions can be divided into four types of knowledge: 1. Understanding the phenomenon of the behaviour and perceptions of stakeholders (Articles I-III), 2. Identifying and classifying solution approaches (Articles IV-V) and 3. Analysing the contribution of proposed solutions (Article VI) and finally 4. Giving recommendations for LOR quality assurance design (Articles III-VI). See Figure 5 for the relations:

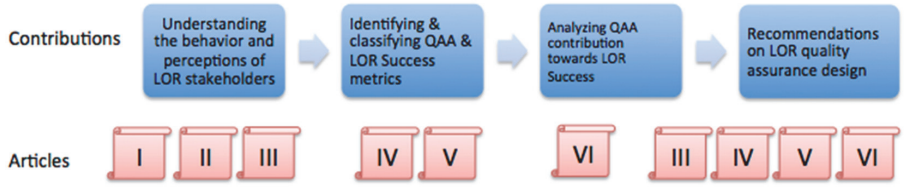

Figure 5: Contributions related to articles

The findings have implications in both research and practice. They extend the current status of theoretical knowledge regarding stakeholder views on LOR quality and success, as well as the relation of these two concepts. The main aim of the dissertation was to explore these topics, in order to "understand" and "explain" (Gregor, 2006) the phenomenon of why LORs remain unattractive for users (Dichev and Dicheva, 2012; Mitchell and Lutters, 2006; Ochoa and Duval, 2009) and how quality assurance approaches could serve as facilitators for LOR success. The research questions are aligned to the findings and contributions through brief summaries in

Table 4: Research questions and summary of findings and contributions

Research question	Summary of findings and contributions
RQ1: **What expectations do users have towards LORs? (Article I)**	LORs are not often successful in attracting users' full attention. LORs have been previously studied regarding the factors leading to success. Article I *confirmed* previous works highlighting lack of quality as one of the most critical factors behind LORs' failures.
RQ2: **What are LOR quality assurance approaches and how can they be classified? (Articles II, IV)**	Previous research has presented different approaches and instruments which could assure LOR quality. This research aimed at *extending* the sets of quality assurance insights from previous works into a comprehensive quality assurance approach framework, which would cover not only the information quality but the system quality and also the service quality.
RQ3: **How do users perceive LOR quality? (Articles II, III)**	In order to understand why users are not using LORs, it its vital to study their perception of LOR quality. Users and developers traditionally have very different ways of looking at subjective and dynamic concepts such as quality. Users' perception on LOR quality have seldom been studied, so the aim of this part of the research was to *extend* what is currently known about users' LOR quality perceptions into a comprehensive understanding of LOR quality from the point of view of the users.
RQ4: **How do developers perceive LOR success and how can it be measured? (Article V)**	There are various perceptions of LOR success in the community. LOR developers' perception on LOR success was explored to *extend* previous studies on the topic, which had been focusing on user/content/contributor growth. There is no consensus on how to measure LOR success. Available success metrics were combined into a framework, which can be used to choose metrics for repositories' success. The contribution of this study is a LOR success metrics framework.
RQ5: **How do LOR quality assurance approaches contribute towards LOR success? (Article VI)**	Previous works have identified quality to be a critical success factor for LORs. This study *explored* the contribution of LOR quality assurance approaches to LOR success. This study showed that LOR QAAs contribute towards LOR success and that successful LORs have expert reviews and user-generated quality instruments in their quality approach. This finding can be used to design QAAs for LORs in the future.

4.1 Theoretical contributions

This thesis contributes towards understanding the perceptions of stakeholders towards LOR quality and success, identifying and classifying quality assurance approaches and success metrics for LORs. This research also show that LOR QAAs have a contribution towards on LOR success. In this chapter, the theoret-

ical and practical contributions based on the findings are presented (See Figure 5). A more detailed view of these contributions, and discussions on how these contributions confirm and extend previous studies in the field is to be found in the appended articles.

4.1.1 Understanding stakeholders' perceptions of Learning Object Repositories' quality and success

Learning Object Repositories fail to receive users' full attention. This thesis explored **the users' behaviour and expectations towards LORs**, to deepen the understanding of LOR quality from the perspective of users. The findings confirm previous research, which states that quality is a critical success factor for LORs (Lund et al., 2010; Ochoa, 2010). The findings of these studies state, for example, that users see quality as "content that fits their lessons and the curriculum of their country" or easy-to-locate OERs which they could not produce themselves. For further details, see Table 5. These findings extend and bring deeper understanding to the previous works of Ochoa and Duval (2009), whose list of quality parameters used for human review of metadata included conformance to expectations. In Article VI, the developers' views on LOR quality were also explored, showing clear differences to the user perspectives. These findings confirm the findings of Ehlers and Pawlowski (2006) and Evans (2004) that there is no universal definition of quality – it varies with the stakeholders and context at hand, therefore making it extremely difficult to gurantee.

Previous works such as Nesbit et al. (2002) have given lists of quality aspects (including aesthetics, accuracy, support of learning goals, usability etc.), but in many cases these do not arise from the users' point of views. Many repositories are built with the views of *developers* as a chief concern, even though it is well known that information systems should be developed through continuous communication and understanding between users *and* developers (Cerpa and Verner, 2009). Before Article III, few studies had been directed towards **understanding how the users see quality**, **trust and re-use of Learning Object Repositories**. This theoretical contribution of understanding the users' views can be used to design rquality assurance approaches that could better meet the expectations of LOR users. User perspectives solely of learning objects have been previously studied with the technology acceptance model (Lau and Woods, 2008), however such studies often remain on a rather abstract level and give little guidance for the practical work of developers, which makes the contribution vital for LOR development.

Table 5: Stakeholder perceptions on Quality and Success of LORs

LOR	Users' perception	Developers' perception
Quality	***OER quality:*** • Coherence to individual teachers' lesson plans and national curriculum(*) • Additional value (something teachers could not produce their own, e.g good use of multimedia)(**) • Scientifically correct(*) • Trusted content – High quality means content from an organisation with good reputation (CERN, Nasa etc.)(**) ***LOR quality:*** • Easy to find OER that fit my curriculum(*) • Easy to download and reuse OER(*) ***Service quality:*** • Interoperability between the repository and learning management systems (e.g. Moodle, Blackboard etc.)(**) (Articles II and III)	***OER quality*** • Complete metadata records(*) • No broken links(*) • Peer-reviewed by users(*) ***LOR quality*** • Operational system with lots of use(*) ***Service quality*** • Sustainable even after the initial funding has ended (*) (Article VI)
Success	***Expectations towards successful repositories:*** • LOR must contain high quality OERs(*) • LOR must be technically state-of-the-art, working and easy to use (*) • LOR must contain a critical mass of OER (to keep up with Google)(*) (Article I)	***Success:*** • LOR functions as a testbed, learning lab or showcase (**) • Change of didactical culture in the teachers' community(**) • Active Users' engagement (*) • Number of OERs that get evaluated (*) • Content growth(*) • Contributions growth(*) (Article VI)

(* Confirmed existing findings, ** Extended existing body of knowledge)

This thesis also investigated **LOR developers' views on successful repositories**. The findings of the 35 developers' qualitative study extended the views of successful project views from previous literature. Previously, success has been seen by the developers as "user involvement"(Ochoa and Duval, 2009), "contributions growth" (Millard et al., 2013) or "sustainable business models" (Downes, 2007) However, based on the findings of this study, LOR can be successful from the point of view of the developers if it has contributed towards change in the teaching culture or if it acted as a testbed and showcase of developers. This

finding extends previous research (such as Millard et al., 2013; Ochoa, 2010; Ochoa, 2011; Ochoa and Duval, 2009; Petrides et al., 2008; Sánchez-Alonso et al., 2007; Thomas and McDonald., 2007) indicating that when looking at "success," typical indicators such as use or involvement are not sufficient metrics to fully evaluate LORs.

4.1.2 Identifying and classifying LOR quality assurance approaches

Each learning object repository tends to have its own quality assurance approach (Tzikopoulos et al., 2007). It might tackle some aspects of OER or metadata quality, system quality and service quality combining aspects of standardization, policies, automatic quality and/or user-generated quality contributed by the community. However, there have been no clear **guidelines on how to select and design quality assurance approaches for LORs**. This thesis systematically identified and classified different quality approaches and instruments which could be used for planning or improving quality assurance approaches for LORs. This study distinguished three levels of LOR quality approaches (see Table 6). This work builds on previous research by Pawlowski (2007) and extends previous studies such as Manouselis and Costopolou (2006) and Petrides et al. (2008), which mainly tackle just the aspects of learning objects quality for LORs, but do not take system or service quality into consideration. Previous quality recommendation frameworks also did not take quality standards and general approaches into consideration. The purpose of this classification was to assist developers to design quality approaches for LORs which would assure not only the information quality, but also the system and the service quality levels.

Table 6: Classification of LOR Quality assurance approaches

Approach	Purpose	Examples
Generic quality approaches	Quality standards present concepts for quality management, independent of the domain of usage	ISO 9000(ISO 9000, 2014) EFQM(Osseo-Asare and Longbottom, 2002)
Specific Quality approaches for TEL domain	Quality management or quality assurance concepts for the field of learning, education, and training, top-down approach	QAA Framework (Consortium for Excellence in Higher Education (2001) Quality criteria, (Pérez-Mateo et al., 2011) BECTA quality guidelines (Charlesworth et al., 2008)
Specific quality instruments	User-generated quality mechanisms for managing specific aspects of quality, bottom-up approach	Ratings (Nesbit et al., 2002) Recommender Systems (Manouselis et al., 2014) Peer reviews (Sanz-Rodriguez et al., 2010) Trusted networks approach (Littlejohn et al., 2008)

The quality assurance classification (Article II contribution) was turned into a comprehensive quality assurance framework in Article IV through a systematic literature review on the topic. The Learning Object Repositories Quality Assurance Framework (LORQAF – see Figure 6) was constructed from the point of view of the LOR developers, but also suggests user-generated quality mechanisms. LORQAF separates quality approaches into:

1. Developer's perspective
2. Technology perspective (automated quality)
3. Expert reviewers' perspective
4. User-generated quality approaches

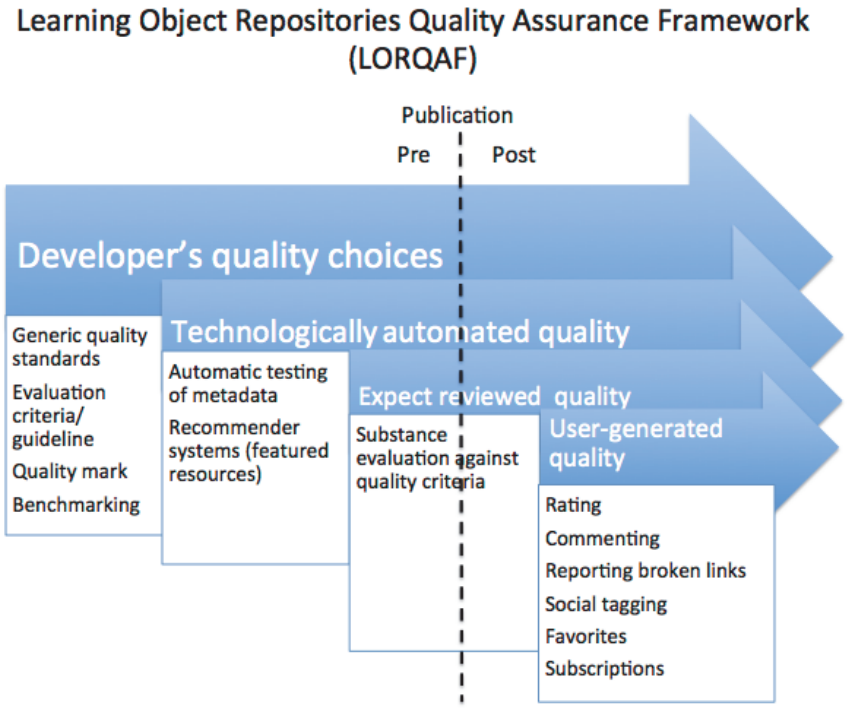

Figure 6: LORQAF

User-generated quality instruments can make quality assurance more affordable, which is a key factor when looking at the sustainability of many repositories after their initial funding ends (Downes, 2007). LORQAF builds upon the work of Atenas and Havemann (2014), who provided 10 quality indicators for LORs: featured resources; user evaluation tools; peer review; authorship of the resources; keywords of the resources; use of standardised metadata; multilingualism of the repositories; inclusion of social media tools; specification of a Creative Commons licence; availability of the source code or original files. The purpose of LORQAF (See Figure 6) is to be used in practice by LOR developers when designing their quality approaches, rather than indicate quality of the LOR, which makes it the first quality assurance framework for LORs taking various quality contributors' perspectives into consideration.

4.1.3 Identifying and classifying LOR success metrics

In order to **define and measure the success of LORs**, a systematic literature review on LOR success metrics was conducted in Article V. The main contribu-

tion of this part of the study is the Success Metrics Framework (LORSMF – see Figure 4 and Table 7) based on the findings of the literature review. This contribution ex-tends the work of Ochoa and Duval (2009) and Millard et al., (2013), who stud-ied LORs' content and contributor base growth over time. The suggestion based on the findings is to extend the growth and frequency of related metrics, while considering the life-cycle of the repository. The sustainability of the repository's business model after its initial funding (often project-initiated) has ended is an important aspect to consider when measuring the success of an LOR. Another aspect which typical metrics do not cover are "transcendent" benefits. This means benefits or outcomes which *developers* see as "successful," such as con-tent, technology or developers' competences enduring after the repository itself has ceased operation. The contribution of this thesis is the identification of basic success metrics, which include (1) Content related indicators, (2) User related indicators, (3) contributor related-indicators and (4) repository-related indicators. (See Figure 4.)

Table 7: LOR Success Metrics Framework (LORSMF)

	Proposed measure(s) for success	Proposed metrics	References
Content related indicators	Size (LOs)	Number of uploaded or harvested LOs	Alharbi et al., 2011; Davis et al., 2010; Leinonen et al., 2010; McDowell, 2007; Millard et al., 2013; Neven and Duval., 2002; Ochoa, 2011; Ochoa, 2010; Ochoa and Duval, 2009; Petrides et al., 2008; Thomas and McDonald., 2007; Vuorikari and Koper, 2009; Zervas et al., 2014
	Daily Growth	Average growth rate per day	Alharbi et al., 2011; Leinonen et al., 2010; McDowell, 2007; Millard et al., 2013; Ochoa, 2011; Ochoa and Duval, 2009; Ochoa, 2010; Petrides et al., 2008; Sánchez-Alonso et al., 2007; Sinclair et al., 2013; Zervas et al., 2014
	Yearly growth	LOs per year	McDowell, 2007; Millard et al., 2013; Ochoa, 2011; Petrides et al., 2008; Zervas et al., 2014
Contributor related indicators	Contributors	Number of contributors	Millard et al., 2013; Ochoa, 2011; Ochoa and Duval, 2009; Ochoa, 2010; Thomas and McDonald, 2007; Petrides et al., 2008; Sánchez-Alonso et al., 2007; Thomas and McDonald., 2007
	Specific contributors	Contributor distribution per category; active contributors	Thomas and McDonald., 2007
	Contributor growth	Average number of contributors in a certain period of time	Ochoa and Duval, 2009; Ochoa, 2010; Sánchez-Alonso et al., 2007;
	Publishing rate	Number of LOs per contributor/time period	Millard et al., 2013; Ochoa, 2011; Ochoa and Duval, 2009; Ochoa, 2010; Petrides et al., 2008; Sánchez-Alonso et al., 2007; Thomas and McDonald., 2007
	Contributon frequency	How often contributor contributes?	Ochoa, 2011; Ochoa and Duval, 2009; Ochoa, 2010; Sánchez-Alonso et al., 2007
	Contributor lifetime	Time period in which contributions actively happen	Ochoa and Duval, 2009; Ochoa, 2010; Sánchez-Alonso et al., 2007
	Collaborative editing	More than one contributor per LO.	Leinonen et al., 2010; Ochoa, 2010; Petrides et al., 2008

User related	Users	Number of users	Leinonen et al., 2010; Millard et al., 2013; Vuorikari and Koper, 2009; Zervas et al., 2014
		Users per year	Millard et al., 2013; Zervas et al., 2014
		Returning users	Højsholt-Poulsen, L., and Lund, T., 2008; Zervas et al., 2014
		Commenting users	Millard et al., 2013
	Use	Downloads	Bond et al., 2008; Davis et al., 2010; Millard et al., 2013; Ochoa, 2011; Ochoa and Duval, 2009; Rosell-Aguilar, F., 2013; Sinclair et al., 2013; Vuorikari and Koper, 2009;
		Views (of metadata)/Popularity	Davis et al., 2010; Khoo et al., 2008; Millard et al., 2013; Ochoa, 2011; Ochoa, 2010;
	Re-use	Re-published	Ochoa, 2011; Ochoa, 2010; Vuorikari and Koper, 2009
		2nd or nth level re-use	Vuorikari and Koper, 2009
Repository related	Lifetime	Age of the repostory	Khoo et al., 2008; Ochoa, 2011; Ochoa and Duval, 2009; Thomas and McDonald, 2007; McDowell, 2007; Millard et al., 2013;

Combining the LORSMF with the findings of developers' views on success from Article VI, conclude that quantitative metrics alone cannot judge the success of a repository, although they can give an indication of whether the interactions which the developers intended to happen between users, contributors and content actually took place. However, the LORSMF can be used to design quantitative success metrics for LORs, as long as success is also studied with accompanying qualitative studies from the points of views of relevant stakeholders (such as users and developers).

4.1.4 Analysing LOR quality approaches's contribution towards LOR success

Article VI analysed **LOR quality approaches' contribution towards LOR success** and showed a clear connection between them within most repositories. Even though quality has previously been idenitfied as a key success factor of LORs (Lund et al., 2010; Ochoa, 2010), the contribution of quality assurance approaches towards LOR success has not been studied before this thesis. LORQAF classified (Contribution of Article IV) quality approaches were analysed based on the most successful repositories according to the success metrics framework (LORSMF), the main contribution of Article V. Most successful repositories contained both both specific quality approaches and user-generated quality instruments. Generic quality approaches and automatic testing of metadata did not seem to have a clear contribution towards LOR success. Based on the findings, maximising the variation of quality approaches alone cannot make LORs successful, the combination of quality contributions from both developers (specific level) and users (instrument level) is the most cost-effective, sustainable solution.

Table 8: Recommendation framework for LOR QAA Design

QAA->LOR Success	High contribution	Contribution	No contribution
Generic quality approaches	-	-	Quality standards such as ISO 9000, EFQM
Specific quality approaches:	Expert reviews Quality criteria	Quality mark Quality framework	-
Quality instruments:	User ratings Commenting Flagging of bad content Sharing of OER with their friends Trusted networks approach	Peer reviews Recommender systems	Automatic metadata testing

This dissertation research shows clear contribution of LOR quality approaches towards LOR success. The most influencial approaches seemed to be "expert reviews and having a quality criteria." The most influential quality instruments were "user ratings, commenting, flagging of inappropriate content, [and] sharing of OER and trusted networks approach." This knowledge can be used to assist LOR developers in designing quality assurance approaches for repositories. This analysis of contribution confirms the previous findings of Davis et al., (2010) which underlined the importance of an active community around the repository to make it successful. This contribution was the first step towards analysing the contribution of LOR quality approaches towards LOR success. This phenomenon should be further studied to show quantitative effects between these two concepts. LOR developers can use this contribution as support for selecting quality approaches for LORs.

4.2 Practical contributions: Reflections on LOR quality assurance design

The practical contributions of this thesis are the recommendations based on the theoretical contributions towards LOR Quality assurance design given at various stages of the PhD research. Quality assurance recommendations directly affected four major European Commission-funded projects: COSMOS, ASPECT, Open Science Resources (OSR) and Open Discovery Space (ODS). These projects ran from 2007 to 2015 (see Figure 7). In this chapter, the practical contributions of this research and their impact for these projects are described.

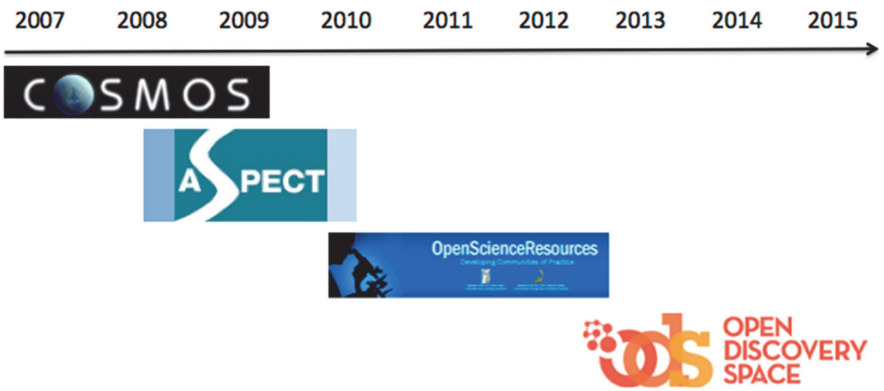

Figure 7 Projects' timeline

The key findings of this research serve practice through the direct integration of an implementation for LOR quality assurance approaches. The practical contributions were knowledge as operational principles or design principles (Gregor and Hevner, 2013), based on findings from the behavioural research throughout the project. The following sections reflect on those principles and their affect on each project.

4.2.1 Case: COSMOS[6]

Initial ideas for quality assurance approach design and implementation were tested already in the COSMOS project, which ran from 2007 to 2009, as is also described in Article II. COSMOS was an advanced scientific repository for science teaching and learning, focusing on astronomy learning materials (Sotiriou, 2008). Open Educational Resources in the COSMOS repository were mainly created by users and uploaded to the COSMOS portal, making this portal a Type 1 according to McGreal's (2008) typology.

In COSMOS, a quality approach was built and implemented by a step-by-step approach (see Figure 9) in order to introduce quality mechanisms for the different stakeholder groups, supporting their individual competences and objectives. Initial awareness was created through online discussions and workshops, where users started to pay attention to the issue of quality and raised their quality concerns. Phases of providing guidance instruments and simple quality mechanisms followed the awareness phase.

[6] http://ea.gr/ep/cosmos/

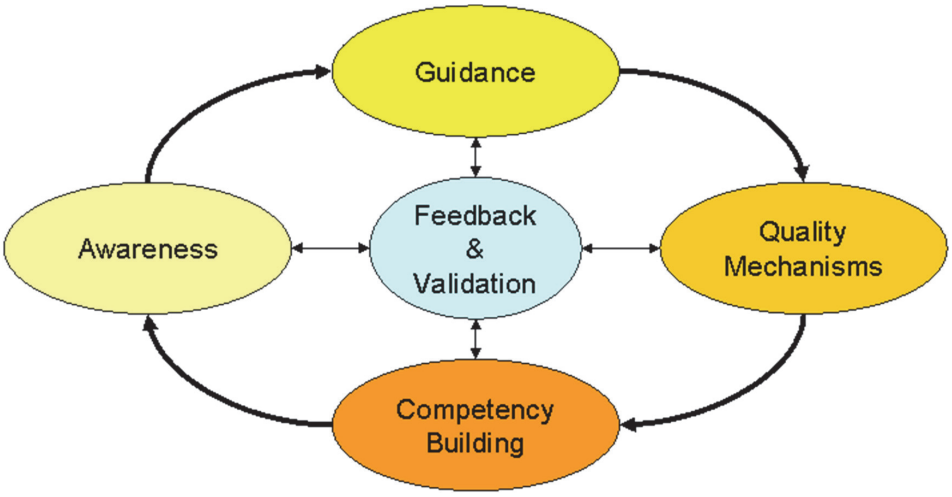

Figure 8 COSMOS quality process

The COSMOS quality assurance approach provided lots of quality responsibility for the users. For this purpose, guides were provided for both the developers and the users, based on the quality criteria of ISO/IEC 19796-2 (ISO/IEC (2009)) and on the user guides of CEN/ISSS (CEN, 2007a, 2007b). However, external evaluation was arranged in order to to back up the user-generated quality instruments. A quality board was selected to review selected resources considered as important for the community. However, this process could not be realised continuously after the cessation of the project's funding, due to a lack of resources. Therefore, peer-review and commenting mechanisms were the instruments retained after end of the project's original funding. Additionally, ranking mechanisms were implemented: top-rated resources, most contributing users, and most re-used resources. See the COSMOS quality assurance approaches, which are visible in the user interface in Figure 9.

The COSMOS quality approach (which was created through application of the initial studies of this thesis) covered all three levels: generic quality, TEL domain-specific and user-generated quality instruments. THE COSMOS portal no longer exists, but its quality-assured contents have been moved to the 'Discover the Cosmos' and 'Open Discovery Space' portals, which means that the LOR can be considered to have been successful in some sense (even though the initial portal has died). Its outcomes have survived with a more mature solution in other repositories. These contributions are further described in Article II.

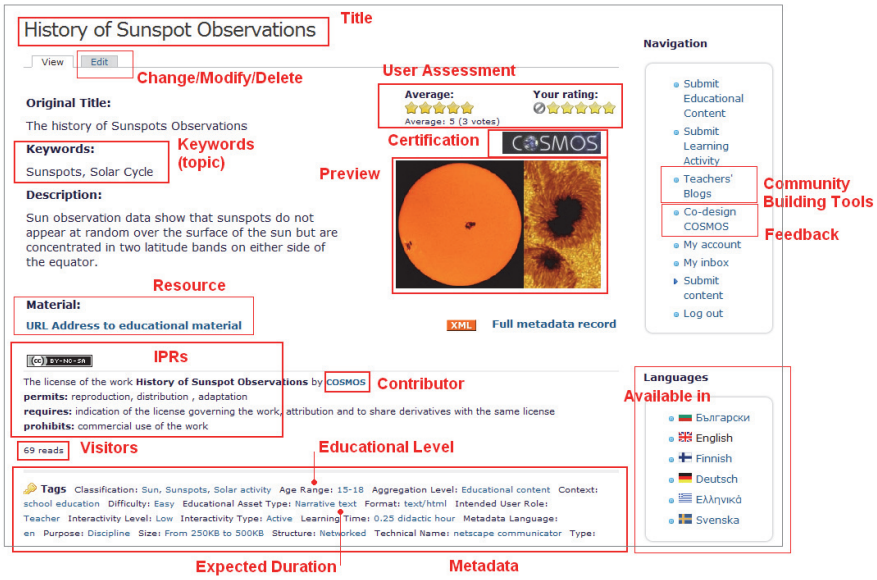

Figure 9: COSMOS QAA user visible instruments (Sotiriou et al., 2009)

4.2.2 Case: ASPECT[7]

The ASPECT project was supported by the European Commission's eContent-Plus programme's Best Practice Network, which ran from 2008 to 2010. This project did not built its own repository, but used European Schoolnet's Learning Resource Exhange (LRE) service to improve the adoption of learning technology standards and specifications (Klerkx et al., 2010).

LRE is a federated repository, which harvests content from other repositories and provides metadata and links to the actual resources, which do not physically reside within the LRE portal. LRE contains over one million resources, however, in the ASPECT project, a sub portal was built hosting only the chosen content providers' resources (about 260 000 learning objects, both commercial and OERs). When designing the LRE quality assurance approach, it was important to focus on the large quantity of resources, which meant that the approach relied on user-generated quality instruments (peer reviews, commenting, flagging) and automated quality (automatic testing of metadata, recommendation systems), as well as the "trusted networks" approach relying on the content providers to deliver high-quality content. The ASPECT portal no longer exists within the LRE, but the quality aspproach implemented and validated during ASPECT is still in use in the LRE portal, which shows that the quality instruments and best practices can outlive the LORs themselves. The findings of this thesis had a practical contribution toward the design of the LRE quality

[7] http://www.aspect-project.org/

approach still in use today (See the QAA visible for users in Figure 10). Lessons learned from the ASPECT project's quality approach were reported further in Articles I and III. (Klerkx et al., 2010).

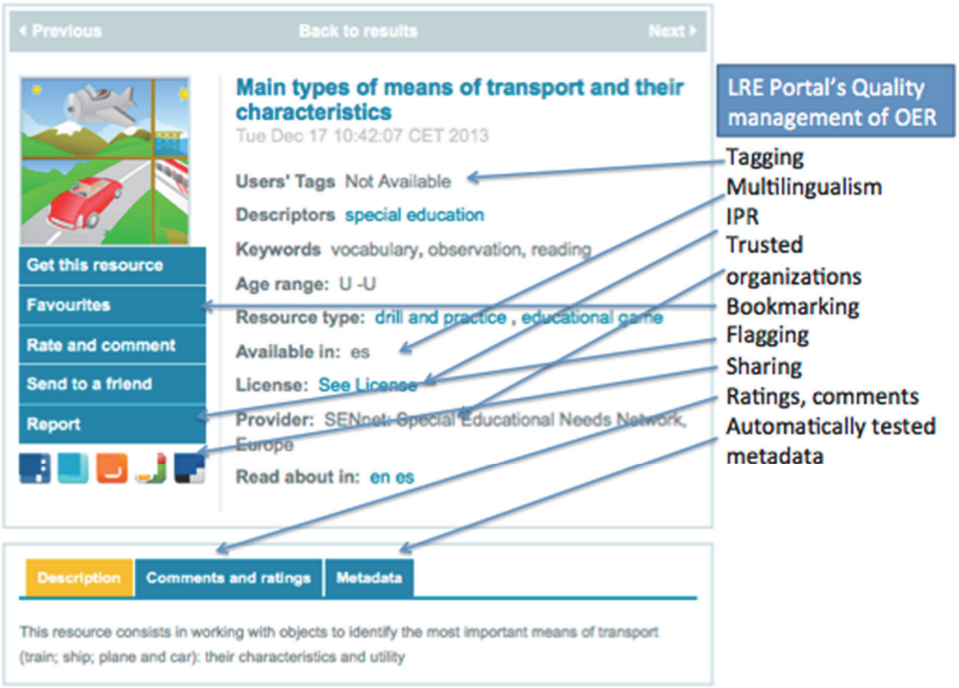

Figure 10: LRE portal's QAA visible for users

4.2.3 Case: Open Science Resources (OSR)[8]

The Open Science Resources (OSR) project ran from 2010 to 2012, gathering educational content from museums and science centres from all over Europe for teachers to use freely in their lessons (Sampson et al., 2011). OSR also allowed teachers to create and upload content for other users of the portal. These prequisites meant that the quality assurance had consider users as content creators, and also that the inevitable cessation of funding, which meant that the QAA had to be sustainable. Based on the findings in Articles I-III, QAA was recommended to include specific quality assurance (expert review, quality criteria, quality mark) and user-generated quality assurance (peer review, commenting, flagging, tagging and sharing). These approaches were also implemented by the OSR portal (Lebzelter, 2009).

[8] http://www.opensciencesources.eu/.

The OSR Quality Assurance Approach consisted of two levels of quality approaches: (1) Technology-enhanced specific quality approaches (expert review of content against predetermined quality criteria, accepted content awarded with quality marks) and (2.) User-generated quality instruments, which included:

User assessment – Users can rate content with stars from 0-5.
Social tagging – Users can add social tags to content
Quality mark of OSR – Trusted content and content that have undergone the OSR technical review certification are marked with this symbol.
Commenting – Users could leave their comments on content
Disclaimer – Users can report content that is poor in quality
Sharing – Users can share content via social networks such as Facebook or Twitter.

(Clements et al., 2012)

Figure 11 demonstrates how quality instruments are visible for LOR users through the OSR portal's interface.

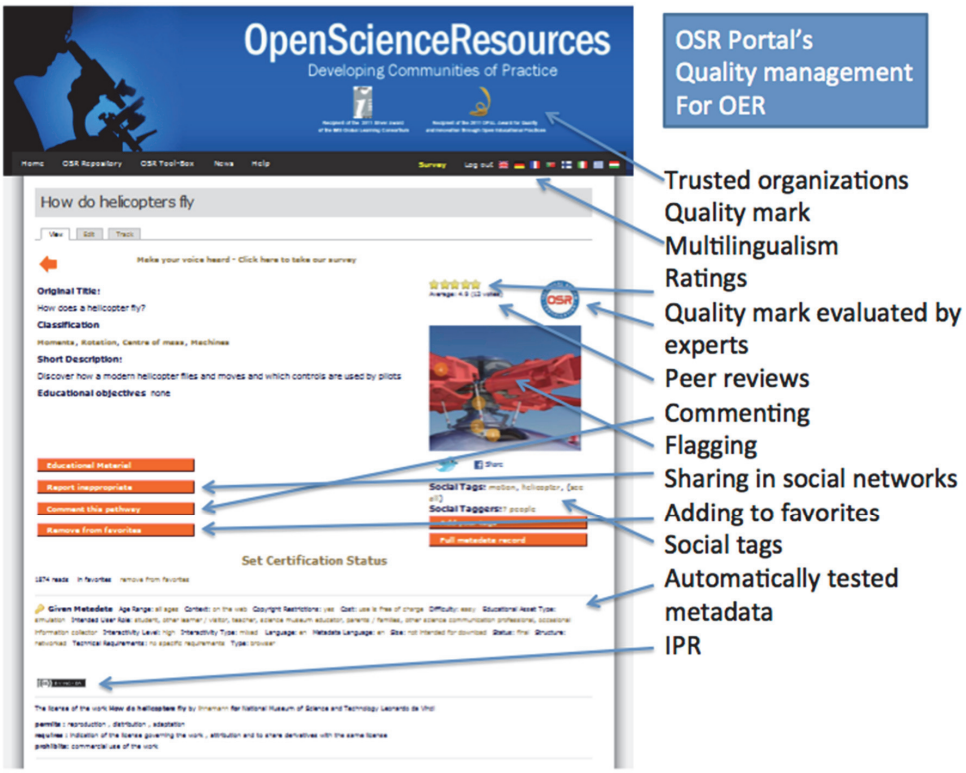

Figure 11: The OSR repository's user-visible quality assurance instruments

The OSR portal is still running and continues to attract users. The relatively small amount of quality learning objects have an audience even three years after the project's initial funding has ended. The OSR content is also harvested by the Open Discovery Space project, which gives further life to the OERs within the portal. The impact of the OSR quality approach was evaluated and reported in Article III.

4.2.4 Case: Open Discovery Space (ODS)[9]

Open Discovery Space was an Europe-wide policy initiative that ran for 3.5years (2012-2015), building a portal of OERs as well as a community for teachers in European schools. One of the major aims was to build a LOR for teachers to adopt. This portal aimed to offer OERs collected throughout school curricula from different parts of the world. Around these OERs, social software tools are offered for networking with other teachers. The social tools and search functionalities of ODS were enriched with services for the production of lessons plans and learning scenarios. The role of the researcher in this project was as a work package leader, focusing on the needs and requirements of teachers (Sotiriou et al., 2013).

A quality assurance approach for the ODS project was designed based on the previous studies (Article III) and already written to its description of work (Ramfos et al., 2011). As ODS was also a repository that harvested other repositories (much like the LRE), reviewing content quality with expert reviews was not selected due to the lack of funding. ODS quality strategy provided the users with a mix of quality assurance instruments (peer reviews, commenting, adding to favourites, tagging, following users, sharing to social networking sites, recommendations, setting licences to clearly show the IPRs of each object, view counts, authors visible etc.). However, there was also automatic checking of metadata. For user-visible features see Figure 12. The project also used the "trusted networks approach," which meant that as it is a federated repository, the harvested learning objects are understood to be of great quality, as they come from content providers that are trusted organisations. Figure 12 presents the quality assurance approaches in the ODS portal interface.

9 http://opendiscoveryspace.eu

Figure 12: ODS Portal's quality approaches

The ODS project ended in Autumn 2015, which makes it difficult to judge the success of this LOR at the time of writing this thesis so soon afterwards. During the project, the repository attracted a user base of 9976 teachers all over Europe. Over 900 communities were created inside the portal, so ODS was definitely successful in creating communities around the OERs within the LOR (statistics gathered in December 2015). It remains to be seen whether this portal lives on now that the funding to develop and maintain it has ended.

4.3 Summary of contributions

In summary, the findings of this thesis have been utilised to design quality assurance approaches for four major international learning object repositories.

	COSMOS	LRE	OSR	ODS
Domain	International Science	International, all disciplines	European Science	International, all disciplines
Content scale	~100 000	<260 000 (ASPECT portal in LRE)	~1200	< 1 000 000

QAAs	Quality standards Expert review Quality criteria User-generated quality instruments (peer review, commenting, flagging, highlighting resources)	Quality guidelines for contributors User-generated quality instruments (peer review, commenting, flagging, highlighting resources, 'travel well resources', trusted networks approach)	Quality standards Expert review Quality criteria User-generated quality instruments (peer review, commenting, flagging, highlighting resources, tagging, sharing)	User-generated quality instruments (peer review, commenting, flagging, highlighting resources, 'travel well resources', trusted networks approach)
Success	The initial COSMOS portal no longer exists. However, the content was harvested for the later projects "Discover the Cosmos" and "Open Discovery Space," therefore LOR can be	The ASPECT portal no longer exists, but the content is available in the LRE and the quality approaches recommended at the time of the project are still in use.	The portal is still running and also harvested by other projects such as ODS.	The ODS portal's funding ended in late 2015, so it is difficult to judge the success of the portal in the future at this point.

Based on the overall lessons learned and the findings of Article VI, it can be stated that most successful repositories included expert review on their quality approaches, but also had put in place community-driven quality instruments such as ratings, commenting and flagging of inappropriate content. It seems that quality assurance requires a combination of TEL-specific quality approaches as well as specific quality instruments to contribute towards the success of a repository. It is vital to remember that user-generated quality instruments can only make repositories successful if the community around the repository is strong enough to support them. Therefore it is the conclusion and recommendation of this thesis that quality assurance for Learning Object Repositories should combine:

1. Expert reviews against a quality criteria
2. User-generated quality instruments such as peer reviews, commenting, recommendation systems, flagging inapproperiate content etc.

These research findings can benefit developers and managers of LORs regarding the choices made towards their quality assurance approaches for future repositories. These recommendations have already been put into practice in four major European Commission-funded projects over the last seven years.

4.4 Limitations and future research

Constraints and limitations have to be taken into consideration when evaluating the usefulness of the findings of this thesis. Such limitations also provide new openings for further research on this field. Firstly, the samples for the quantitative studies were relatively small and therefore cannot be considered to be generally applicable. The teachers who answered the surveys also possessed above-average skills in ICT, due to their own interest in participating in learning technology projects, which provided the test bed for our studies. This should be considered when evaluating the findings of this study.

Quantitative studies also provided merely descriptive statistical information on the phenomenon, whereas more rigorous methods such as theory validation through factor analysis and structural equasion modelling could be conducted to enforce and validate the two theoretical frameworks provided (LORQAF and LORSMF). Another limitation of this study is that it looks at concepts of LOR quality and success only from the perceptions of two stakeholder groups of users and developers. Further perceptions from other stakeholder groups, such as investors, learners or policy makers, should be considered to augment the knowledge generated.

This research focused strongly on 'internal' LOR quality aspects such as functionalities and criteria to increase and maintain quality of the OER inside the repository. However, there are other 'external quality' considerations behind success of the repositories, such as the quality of organisational support around the repository: Do schools provide needed support for teachers to use LORs? Is there reward systems in place to motivate teachers to contribute towards repositories. These aspects of external quality surrounding the LOR were not studied further.

Based on the overall gaps identified within this research process, it can be stated that the following aspects of this phenomenon would require further investigation:

- Future research should be conducted to find a stable measurement for LOR success metrics, which would contain both quantitative and qualitative means of measuring success, which would also reflect users' perceptions of success.
- Contibution of LOR quality approaches towards LOR success should be studied with more rigorous quantitative methods to validate these findings

- LOR quality and success perceptions should be studied from the perspective of other stakeholders (policy makers, investors, learners etc.)
- Life cycles of LORs should be studied with qualitative methodologies in order to understand differing benefits and outcomes of LORs for different stakeholder groups.
- When studying the success of LORs, indirect "success" or "benefits" (such as effects on developers' increased competences or the attitudes of teachers towards technology) should be investigated to determine "success" beyond simple indicators such as "growth in content and contributions."
- The LORQAF can be used to support decisions for quality approaches and classify future quality approaches. The quality approaches identified should be studied in the future for their actual effects on the quality of the LORs with quantitative methods.
- Longitudinal analysis of LORs could provide a deeper understanding on the phenomenon of LOR success from the perspectives of different stakeholders.

Despite such potential research aspects worth elaborating in the future, this thesis has used multiple methodologies to explore Learning Object Repositories' quality approaches contribution to Learning Object Repositories' success. Whereas previous studies neglected the perspective of users and developers, these distinct views were included for theoretical and practical elaboration of this thesis. While further statistical methods should be used to test the effects of LOR quality assurance approaches on LOR "success" in the future, this exploratory work provided a conceptual basis for future studies. This research concludes that a combination of expert reviews with user-generated quality instruments contributes towards LOR success. LOR developers can use the quality assurance approach recommendations given in this thesis to design quality assurance approaches for repositories in the future.

YHTEENVETO (FINNISH SUMMARY)

Avoimet oppimateriaalit ovat yleistyneet viimeisen parinkymmenen vuoden aikana ja tulleet verkkoon opettajien ja opiskelijoiden saataville. Näitä materiaaleja on tyypillisesti kerätty oppimateriaalipankkeihin, jotka ovat selainpohjaisia digitaalisia kirjastoja, joiden ympärille on luotu materiaalien hakua ja uudelleenkäyttöä edistäviä palveluja (esim. verkostoitumispalvelut, materiaalien muokkauspalvelut, laadunvarmistuspalvelut jne.). Useimmille oppimateriaalipankeille ei kuitenkaan löydy potentiaaliaan vastaavaa määrää käyttöä siksi niistä monen voidaan katsoa epäonnistuneen. Aikaisemmissa tutkimuksissa on havaittu laadulla olevan kriittinen rooli oppimateriaalipankkien menestyksessä. Kuitenkaan niiden laadun varmistukseen ei ole luotu selkeää, yhdenmukaista ohjeistusta.

Aikaisemmissa tutkimuksissa on keskitytty listaamaan laadunvarmistusmenetelmiä, mutta niiden tapoja edistää oppimateriaalipankkien menestystä ei ole tutkittu. Laadun ja menestyksen mittaaminen on haasteellista, sillä molemmat käsitteet ovat subjektiivisia ja dynaamisia luonteeltaan. Näihin aikaisempien tutkimusten haasteisiin ja aukkoihin vastattiin tässä väitöskirjassa tutkimalla oppimateriaalipankkien kriittisten sidosryhmien eli käyttäjien ja tietojärjestelmäkehittäjien näkemyksiä laatuun ja menestykseen kvalitatiivisin ja kvantitatiivisin tutkimusmenetelmin. Tässä väitöstutkimuksessa koottiin viitekehykset oppimateriaalipankkien laadunvarmistukselle ja menestysmittareille. Sidosryhmien näkemykset laadun ja menestyksen käsitteistä syventävät aikaisempaa teoreettista tutkimustietoa auttaen myös sovelluskehittäjiä suunnittelemaan laadunvarmistusmenetelmiä, jotka edistävät oppimateriaalipankkien menestystä käytännössä.

Tutkimuksessa havaittiin, että asiantuntija-arviointi edistää yhdessä käyttäjien luoman laadunhallinnan (esim. suosittelujärjestelmien, vertaisarviointien, kommentointimahdollisuuksien jne.) kanssa oppimateriaalipankkien menestystä.” Näiden tutkimustulosten perusteella luotiin ohjeistus, jota sovelluskehittäjät voivat käyttää apuna oppimateriaalipankkien laadunvarmistusta suunnitellessaan. Näitä ohjeita on hyödynnetty käytännössä neljän suurehkon eurooppalaisen oppimateriaalipankin laadunvarmistuksessa.

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ORIGINAL PAPERS

I

LEARNING OBJECT REPOSITORIES CHALLENGING GOOGLE - USERS POINT OF VIEW

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LEARNING OBJECT REPOSITORIES CHALLENGING GOOGLE – THE USERS' POINT OF VIEW

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Abstract

Open Educational Resources (OER) are most commonly accessible through Learning Object Repositories (LORs) or databases allowing users to search by the metadata records (e.g., information on contents, target group, legal aspects) attached to the resources. Many LORs are currently not being used for their full potential. This paper examines how repositories can be used beneficially for teachers to find resources for their lessons in comparison to efficient search engines like Google. In our study, we analyze how teachers– the key target group of users– search for OER by using the search engine Google as well as using Learning Resource Exchange (LRE), an LOR with a considerable collection of OER. Based on a experiments along with a quantitative empirical study, we survey which searching features seem to help teachers in locating relevant resources for their lessons. Based on our findings, we derive recommendations for searching OER as well as setting up Learning Object Repositories which would serve the users and therefore generate more re-use of the existing OER.

Keywords: Open educational resources, Learning Object Repositories, Learning Resource Exchange, Search engines, Google, Teachers

1 INTRODUCTION

In this paper, we discuss the advantages and pitfalls of Learning Object Repositories (LORs) for teachers when searching for resources to prepare their lessons in comparison to current practices, in particular using a well-known, efficient search engine like Google. Which advantages do these two ways of educational resource discovery have for the teachers? Are there advantages in using LORs rather than search engines? We present results of an empirical study where teachers (n=46) around Europe prepared lessons by searching Open Educational Resources (OER) with a Learning Object Repository as well as with Google. As our sample of teachers was limited, we gathered data by questionnaires and complemented the findings by interviewing the teachers in order to get an explanatory perspective.

Learning objects are defined as digital objects which can be used, re-used or referenced during a technology-supported learning process [1]. A Learning Object is defined as "any entity, digital or non-digital, that may be used for learning, education or training" [2] (in our case, we consider only digital resources). Educational Resources can be defined as Learning Objects that can be employed in technology-supported learning [3]. Learning Object Repositories are collections of Learning Objects accessible to users via a network without prior knowledge of the structure of the collections [4]. Distribution of Educational Resources is most commonly done via LORs [5]. However, many LORs are currently not utilized to their full potential [6]. This paper investigates the users' point of view in using LORs and search engines for searching OERs.

Our key findings conclude that teachers appreciate certain features of LORs, which search engines like Google do not cover. These features can be, for example, searching by curriculum related topics or searching by a certain targeted age group. These features were appreciated by the teachers as it made them find the resources faster. Consistently, when only a simple key word search is required, search engines provide better results. Our testing also showed that teachers who knew about the LOR before the beginning of the test, found resources using the LOR quicker than those using Google. However, being able to find the resources quicker did not mean that the teachers would be convinced about the resources' quality, neither when searching with the LOR nor the search engine. In our study

it also became clear that repository features like searching by topics are not enough for the LORs to challenge search engines' power for reaching millions of resources with one search.

We conclude that Learning Object Repositories provide additional value especially to teachers with low skills in ICT. However, to really challenge search engines for users' attention, repositories need to provide easy access to highly relevant resources which the users can trust to be high quality.

2 SEARCHING FOR OPEN EDUCATIONAL RESEOURCES

Teachers preparing lessons use the internet mostly with the goal of 'seeking resources' [7]. Although general-purpose searching such as Google is powerful, when searching for some specific purpose such as for educational resources, using additional means like repositories could provide proof to be use-worthy [8]. In this study, we aimed to understand the search possibilities which the teachers face when seeking for open educational resources online. In particular, we were interested in discovering advantages that Learning Object Repositories provide towards the apparent dominance of search engines like Google.

2.1 Search engines / Google

Search engines have become the quickest way of retrieving information throughout the last two decades. Even better results can often be obtained by searching information from databases, especially if one is looking for information for a specific purpose [9]. In the turn of the 21st century, many search engines were still competing for the users' attention [10], however, in the last 10 years, Google has grown to be the dominant search engine of choice for most users [9,11]. This is the case also for most teachers when they are searching educational resources for their lessons. Google was chosen for this study to represent a variety of easy-to-use search engines based on free-text searching of resources from public websites not only for its popularity, but because it has become predominant in its field (e.g. "to Google" has become a de facto verb in the English language by 2003 [12,13])

However, past research [14,9], has recognized a serious concern for quality of searched resources retrieved by a search engine such as Google. There also seems to be a common belief that when a user wants to find something quickly and is not concerned about the quality – they use Google [15].

Teachers can search resources for their lessons by simply using Google's text-based search engine. This method provides them with various resources from all over the internet, most not made for the purposes of education. Since 2004, Google has provided an alternative text-based search for academics called Google Scholar [16] which searches academic information on any topic. However in 2011, a similar service for finding educational resources did not exist. Google provides help to educators by providing search guidance, accompanied by classroom activities and quizzes. Users can also rate content in Google to exchange opinions on the (subjective) quality of the results.

These features, however, do not remove the fact that, when searching educational resources by Google, teachers can never be sure that the resources located are suitable for educational purposes.

2.2 Learning object repositories / Learning Resource Exchange (LRE)

Learning Object Repositories (LOR) have been set up for educational users to store and provide resources made for the sole purpose of teaching. These LORs cover various educational levels and topics, and are developed by using a variety of different technologies. They store learning objects and/or associated metadata descriptions and offer a range of services that can vary from advanced search mechanisms to intellectual property (IPR) management [17]. Most LORs provide an alternative source for discovering educational resources beyond simple text-based search. Many LORs provide specialized features or functionalities for teachers to locate desired OERs [18]. Previous research [6] on LORs has proven that several LORs are not used up to their full potential, which indicates that even with advanced search methods and the specialization towards the domain of education, LORs are not fully appreciated by users when searching educational resources. This research investigated some of the reasons why.

In our study, we used the Learning Resource Exchange (LRE) as an example for a LOR. The LRE is a pan-European federation of Learning Object Repositories [19]. The service is offered to stakeholders providing digital content, such as ministries of education, commercial publishers, broadcasters, cultural institutions, and other non-profit organizations offering online content to schools [20]. It

currently contains the records of over 39 000 learning objects and 90 000 assets. LRE was selected for the testing as it uses many of current cutting edge functionalities for such a repository, including a standards-compliant application profile, harvesting other repositories, automatic vocabulary banks and efficient search mechanisms, as well as user-centred features like rating, tagging and commenting.

The LRE provides various advanced ways of searching for educational resources beyond simple free text search. These features vary from searching resources based on curriculum topics, age groups of students and different languages. After searching with these basic methods, users can also limit the search by resource types, languages, age group or the resource's provider. Results can also be sorted by popularity or ratings. Educational resources can also be located by user tags in the LRE. In the main page of the repository, there is also a list of links directly to all the curriculum subjects. The LRE's search functionalities are common to many LORs up to date [17].

To conclude, both, search engines and repositories, provide teachers with methods to search for resources for lesson preparation. Only repositories guarantee that the results are purely created for educational purposes. Resources also provide a set of alternative features (such as topic and age group searches) beyond basic free text search for resource retrieval.

3 SETTING AND METHODOLOGY

The project "Adopting Standards and Specifications for Educational Content (ASPECT)" is a Best Practice Network for educational content that aims at improving the adoption of learning technology standards and specifications [21]. Within the project, experiments were carried out in order to assess in real contexts how the implementation of standards and specifications on LRE content leads to greater interoperability and cross-border re-use of the content. To enable re-use, however, it is necessary to understand and analyze users' preferences, practices and behaviour. This paper covers the question how users perceive and utilize different search options in their everyday life. As an exemplary setting, we therefore chose to compare a widely used search engine with a specialized repository. In other words, to validate the LRE portal by studying the advantages/disadvantages of using the LRE over search engines, like Google.

In our setting, we have used a mixed methodology combining quantitative and qualitative methods, in particular a survey and, to deepen the understanding of the issue, interviews.

For the experiment, we chose the following basic test criteria:

- Time taken to find the resource in a portal (the less the better)
- Number of clicks to start obtaining results (the less the better)
- Number of resources in correct language (the more the better)

Additionally, we analyzed aspects regarding trust and quality as well as parts to understand advantages of both, LRE and Google [22]. In the following, we describe the detailed characteristics of the validation group and our test setting.

3.1 Validation Group

For the validation, we selected four advanced teachers (considered focus teachers) from Romania, Belgium (Flanders), Lithuania and Portugal and ten general teachers from each of the same countries (total 4 plus 42, i.e. 46 teachers), three workshops were organized. During the workshops, teachers had to:

- Fill in questionnaires to obtain background information on the teachers, their attitudes towards resources, sharing, of resources and how they work with them to enable to us to understand the type of teachers we were working with.
- Carry out experiments on discovery and reuse of resources to understand how they search and interact with the Aspect LRE.
- Carry out experiments on packaging of resources and DRM.
- Fill in questionnaires on their views on resources, searching options, resource packaging and DRM.

The teachers selected were mathematics, science and/or technology teachers with some experience with ICT and Learning Resources and currently teaching 6 to 21 year old students. Up to 80% of the teachers had advanced ICT skills and previous experience with resources, repositories and international projects so it was important to take into account when analysing the results they consisted of advanced teachers and do not represent the general teacher population. As a consequence, it must be taken into account that if these teachers found the project tasks and concepts too difficult or uninteresting, one can be reasonably certain that this will apply even more so to teachers with average or below average levels of ICT competence.

3.2 Experiment Description

The teachers completed a questionnaire regarding their background and skills, as well as expectations towards international sharing of educational content. Then they were asked to complete a task where they created a lesson plan on a topic of their choosing. This lesson plan had to include:

- 1 image
- 1 simulation
- 1 interactive simulation
- 1 animation to be used as an activity/exercise by the students

30% of the teachers were using Google for this task, 70% were using the LRE to complete this task. As teachers in general had more knowledge on using Google, this was decided to be the sufficient division. Teachers were given two hours to complete this task. After the first task, teachers answered the second questionnaire regarding the task and how LRE/Google had worked for them while creating the lesson plans. On the second test, were asked to find three resources with a set of characteristics (language, topic, type) using the LRE and three with the same set of characteristics using Google. To find each resource, the teachers had up to 15 minutes. (E.g. Using the LRE: Look for resource 1 with the following set of characteristics: Kangaroo animation for 10 year-old kids; language, topic, type…)

After the second task, teachers were asked to complete questionnaire 3, concerning feedback on the task they had just completed. At the end of the experiment, teachers could give feedback on their opinions towards working with LRE and Google in a group interview session.

4 RESULT AND DISCUSSION

In this section, we discuss the results of the surveys addressed to the teachers after completing their experiment. The results of the statistical analysis can only give us some indication on the teachers' attitudes because the sample of the survey was rather small (n=46). The survey results were backed up by a qualitative analysis through interviews of the teachers.

95% of the teachers said that they mainly find educational resources by searching via keywords. This indicates that they are familiar with Search engines as their primary source of information retrieval. Our study also showed that all the teachers were familiar with Google as a search engine (see Fig. 1), over half of them said they use Google every day (see Fig 2.). This finding supports the general conception that Google is dominating the information retrieval field [9,11].

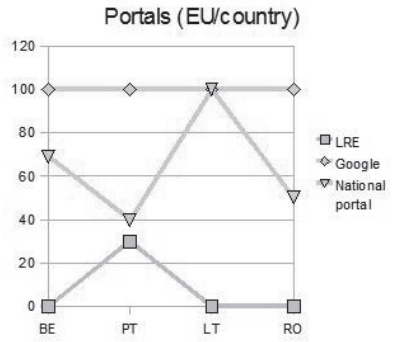

Fig. 1. Teachers' knowledge on LRE/Google before completing the tests

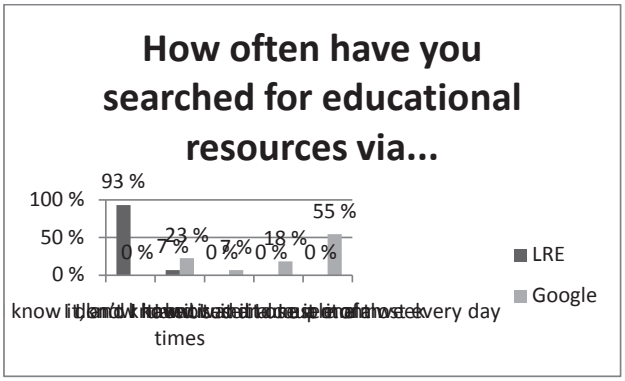

Figure 2: How often have you used LRE/Google to search for educational resources?

39% of the teachers said they use other portals to search for educational resources. A country-based comparison also shows that even though many countries have their own national portals for searching open educational resources, they are not all well known to the teachers (see Fig 1.). Interviews with the teachers also revealed that most teachers are used to searching via keywords. Especially those teachers, who were not highly skilled in ICT, were happy to be offered an alternative to Google in which search results were a) always educational and b) clearly licensed. Teachers claimed that by using a repository "They didn't get lost" in the unlimited pages that the Internet provides, saving them time in the process. When they were using Google, they often drifted from one page to another and forgot what they were searching for in the first place.

Country comparisons show that teachers who knew about the LRE before the beginning of the experiments found resources using the LRE quicker than with Google (see Fig. 1 and Fig. 3). On the other hand, being able to find the resources quicker did not translate into actually being convinced about the resource quality, neither with Google nor with LRE (See Fig. 4). Quality has been recognized as a serious problem of the LORs by many studies [5,23,24,25,26], our study confirms the same finding as well as suggests that quality of educational resources is not just the problem of repositories, but the whole web-based search results in the internet.

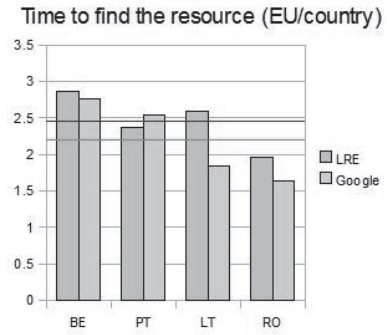

Fig. 3. Time it took for the teachers to find the resources fitting their lesson plans, per country, with either the LRE or using Google. [0,1] means up to 5 minutes,]1,2] means up to 10 minutes,]2,3] up to 15 minutes,]3,4] did not find the resource within the 15 minutes they had. Lines indicate average time it took the teachers to find the resource using the different portals

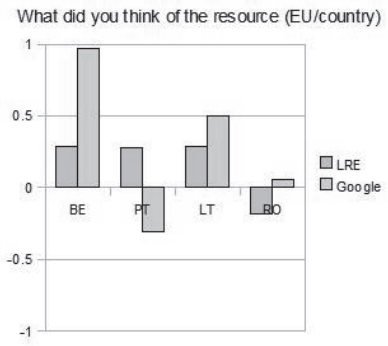

Fig. 4. Teachers evaluation of the resources found, per country. -1: Not good; 0-Don't know; 1-Good

Teachers were also evaluating search related features of both the LRE and Google. The key findings of this test are described below: (See fig. 5)

Using the LRE, teachers found more relevant content to the topic they were search than when using Google. However, only 38% of the teachers found relevant content with LRE, which means that the most of teachers are generally not finding the resources that they want when preparing their lessons regardless on the repository or search engine they are using. This finding also gives us an indication to why the LORs suffer from lack of use [6].

When using Google to search, teachers found almost no broken links or missing preview pictures whereas when 19% found broken links when searching content with the LRE. As already discovered by Downes in 2001 [27], one of the big obstacles of LORs is to keep all content updated. This issue seems to have been resolved by Google's algorithms.

By using the LRE, teachers could also locate resources easier with the appropriate age group of their pupils. When using Google, there is a bigger chance for the resources to be targeted to an inappropriate age group.

With the LRE, the teachers can search directly by 'topics' or 'subjects', which was a feature appreciated by 78% of the teachers when making their lesson plans. Teachers found resources to be more relevant to their searched topic better when using the LRE. Metadata instances seem to help them discover the curriculum-related resources they need slightly better than using search through the whole internet with Google.

7% of the teachers appreciated the rating system of the LRE when locating objects, where only 1% said the same way about Google's rating. As Google's user base is not registered solely to teachers, teachers cannot really trust the rating system to provide any reliable hints on the quality of resources for educational purposes. Our research findings indicate that ratings are not a functionality which teachers look at when searching for educational resources, which seems to be a step back for the field which believes [28] that user ratings can be an answer to the growing problem of Quality assurance.

Both the LRE and Google seem to provide a large amount of resources in several languages. However, Google manages to provide more content in the language in which the teachers are searching. Still, only 26% of the users thought that about the resources they found with Google. The language problem can partly explain the problems that teachers have when using multinational repositories like LRE – if they cannot find the correct language version of the resource they are not likely to consider it relevant. Many teachers do not have the time or even proper language skills to start translating the resources back to their mother tongues. As seen by Tzikopoulos & al. [17], harmonization of languages is seen as key issue in the field of LORs.

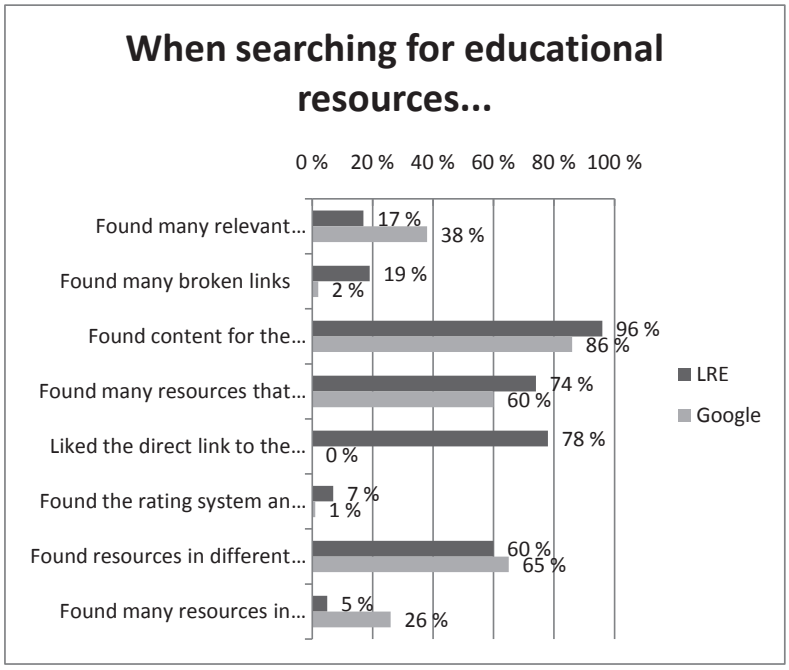

Fig. 5: Search related features of LRE and Google from the point of view of the teachers

Summarizing our findings, both ways of searching and finding resources seem useful. Whereas Google provides a large amount as well as high technical quality, LRE (and educational repositories in general) provide domain-specific functions and specialized contents which are especially useful to inexperienced users. We have also found certain pitfalls and barriers for educational repositories as well as search engines, with language and quality issues as the most important challenges.

5 CONCLUSIONS

Our research supported many of the research findings in the field of Learning Object Repositories. We have also gotten new insights and findings on user behaviour and opinions when comparing LORs search capabilities in comparison with search engine retrieval. On the first view, our findings on searching open educational resources seemed quite discouraging. Many teachers had trouble locating relevant resources for their lessons with both Google and LRE search. There is no doubt that relevant resources are out there but they are (for some users) lost within the amount of information available for teachers, and therefore are majorly underused. Part of the problem can be explained by teachers not having enough training in searching for information from the internet but a major part of it also comes down to the tools providing these services for them. Based on our research, we would argue that Learning Object Repositories such as the LRE are not, so far, up to the challenge of getting teachers' attention. However, those findings have clearly identified how to match teachers# competences and preferences with necessary performance of search tools – this is a key outcome of our research.

On top of this, both LRE and Google have certain advantages from the point of view of teachers when searching for resources for their lessons. Around 75% of the teachers said that they would prefer to use Google to search, 25% preferred LRE, because it provides only educational resources and one can find appropriate resources in less time. Issues, which were bothering the teachers with LRE, circulated on the searching functionalities as well as the quality of resources found. Teachers seem to recognise three aspects when it comes to a successful repository:

1) The repository must contain high quality resources,

2) The repository must be technically up to date working (easy to use) and

3) There needs to be a critical mass of content in which to search for resources.

ACKNOWLEDGEMENTS

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II

IMPLEMENTING QUALITY STANDARDS FOR KNOWLEDGE-INTENSIVE ORGANIZATIONS

by

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Implementing Quality Standards for Knowledge-Intensive Organizations

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Abstract

Quality standards are widely discussed and requested in particular in knowledge-intensive domains, such as the service industry and in particular education. However, no quality standard for this domain has gained a wide adoption or common acceptance yet. This paper shows a classification of quality standards. The classification supports decision makers as well as users to choose appropriate quality standards for their context. The context of this paper is quality development using Open Education Repositories. A focus is the implementation process taking barriers against quality management into account. We show a mix of methods and mechanisms to increase quality and to create quality based on trust. The paper shows a sample case study of how to combine different standards, combining quality aspects from an organizational, product- and user-driven point of view.

Key Words

Quality Standards, Organizational Quality, ISO/IEC 19796, Quality Adaptation Model, Individual Quality

1 Introduction

This paper shows how existing quality approaches can be combined to fit the needs of an organization. Based on a classification of quality standards, a method to adapt quality standards to organizational needs is shown. Following this method, a case study for a combination of approaches for an Open Education Repository is shown.

Knowledge-intensive organizations have to be increasingly competitive on the global market. In particular educational organizations, new requirements arise (Ehlers et al., 2005). However, there are currently no commonly accepted approaches for this specific sector (Kefalas et al., 2003). Many obstacles to achieve quality can be found in practice. Firstly, organizations have to choose a suitable approach from the variety of existing approaches meeting their needs and requirements. Secondly, the successful implementation depends on a variety of aspects to overcome typical barriers (Masters, 1996). Thirdly, quality becomes more and more user-oriented (Ehlers, 2004). In particular for Open Educational Resources (OER) (Pawlowski, Zimmermann, 2007) and community-based learning approaches, user-centered quality the aspect of participation is of vital importance. Currently, 64% of OER repositories use a quality policy (Tzikopoulos et al., 2007), however, the instruments and approaches are very different and not well studied regarding their success.

The main research question of this paper is how existing quality standards can be utilized and adapted by educational organizations. We address the question how to achieve high quality in a

setting with rapidly changing resources and how to implement these as repositories and user-generated content are still a challenge in terms of quality (cf. Downes, 2007)..

The paper outlines how quality approaches and standards can be classified and applied. The paper bases on a long-term research regarding the adaptation and individualization of quality approaches (Pawlowski, 2007). The approach of individual quality for organizations (Pawlowski, 2007) focuses on the adaptation of existing quality approaches to a specific context. To show the deployment process, the Quality Adaptation Model is introduced. The approach is illustrated in a case study to apply quality management in a large consortium for open educational resources and learning object repositories.

2 Quality Approaches and Standards

2.1 Quality Approaches for Knowledge-Intensive Organizations

Quality for knowledge-intensive organizations and in particular for educational organizations has become an issue of increasing importance in both researchers' and practitioners' communities. Quality can be understood in many different meanings and on different levels. As a basic definition, quality can be defined as "appropriately meeting the stakeholders' objectives and needs which are the result of a transparent, participatory negotiation process within an organization. Moreover in the field of E-Learning, quality is related to all processes, products, and services for learning, education, and training, supported by the use of information and communication technologies" (Pawlowski, 2007).

A variety of approaches has been developed and implemented in different sectors such as Higher Education (Cruickshank, 2005), schools (Greenwood & Gaunt, 1994), in the E-Learning sector (SRI, 2003) or the service industry in general (Yasin et al., 2004; Douglas & Fredendall, 2004). All those approaches differ in various aspects, such as scope or methodology.

The variety of approaches differ in their scope, objective, or methodology (for a discussion of the variety, see Pawlowski, 2007). A typical classification (cf. Pawlowski, 2007) distinguishes the following three classes:

- *Process-orientation*: Quality is managed and / or assured during the development process of a product or service. The main idea of this class of approaches is to provide support to stakeholders in their daily operations. Process-oriented quality approaches do not necessarily guarantee the quality of the outcome (products / services) but provide a framework to achieve quality results. Examples are process guidelines how to develop E-Learning courses or how to develop a curriculum between partner universities.
- *Product-orientation*: Quality is understood as the characteristics of the outcome of an organization. Examples of products in the field of education are study programs, courses, E-Learning modules or curricula.
- *Competency-orientation*: Quality is managed by assuring that stakeholders involved in educational settings have certain competencies to achieve results. An example is the assessment of didactical or language competencies of a teacher / docent.

As already mentioned, a variety of approaches has already been implemented in educational organizations – in some cases, generic quality approaches have been adapted to the field of education, in other cases, specific quality approaches have been developed.

Generic approaches such as ISO 9000:2000 (International Organization for Standardization, 2000) or EFQM (2003) are used to some extent in educational organizations (around 26% of organizations use a generic approach according to Pawlowski, 2007). The main reasons for this rather high usage are their acceptance, their wide popularity, and organizations' willingness to certify and promote quality, both internally and externally. For educational organizations, the effort to adapt those approaches is very high. Usually an organization has no domain-specific guideline to provide process descriptions of their educational processes. In spite of those difficulties, a variety of successful examples (e.g., Cruickshank, 2003; Barron, 2003) show that it is possible to use and utilize those approaches in the context of learning, education, and training but the effort to adapt these standards is still high.

To avoid high adaptation efforts, *specific approaches* for the field of learning, education, and training have been developed. As already mentioned above, they differ in scope and methodology, ranging from quality management systems for education (BLA, 2005) to content development criteria (Leacock & Nesbit, 2007) or competency requirements (Ehlers, 2007). This also includes accreditation requirements or guidelines which combine process-, product-, and competency-orientation. Finally, a variety of related approaches for a specific quality objective exists. Those approaches are used to assure quality for very specific aspects, such as data quality or interoperability (cf. Currier et al., 2004; Ternier et al., 2008). An important approach for Open Educational Resources and Learning Object Repositories is user-driven quality assurance using recommendations based on user behavior and characteristics. This approach can provide quality statements when reaching a certain critical mass of users.

Another class of specific approaches incorporate instruments and mechanisms which implicitly address the issue of quality: *Ranking and recommender systems* aim at providing support to find resources according to the needs of individuals and organizations (Manouselis & Costopoulou, 2007, Manouselis et al., 2009). Relating this to our quality definition, this means that these instruments try to provide resources to fit the needs and requirements of stakeholders. These instruments are rarely seen as quality approaches. However, recommendation systems are frequently used in particular for OER repositories, around 43 % use recommendation and ranking mechanisms (Tzikopoulos et al., 2007). A key instrument is a recommendation mechanism based on metrics (Duval, 2005, Vuorikari et al., 2007). It has been shown that these systems can be successfully used to fulfill the stakeholders' needs and requirements. This group of approaches can therefore be seen as promising to contributing towards individual quality.

In general, all quality approaches – generic, specific, and related approaches – can be helpful for educational organizations. However, several weaknesses exist: First of all, most approaches are not comparable, only expert users are informed on scope and applicability for a certain context. Secondly, the adaptation efforts for generic approaches are in many cases to high. Additionally, specific approaches are usually not widely used and not well known in the community (Pawlowski, 2007).

2.2 Quality Standards

Quality Standards are a specific class of approaches, being formally endorsed by a standardization organization, such as the International Organization for Standardization (ISO) or the European Standardization Body CEN. This means that there has been a public debate and discourse on the approaches with a formalized consensus process. This can be seen as an expert evaluation process

leading to a higher quality of the approach itself. Furthermore, quasi-standards are not endorsed by a standardization organization but have a wide public acceptance so they are perceived as standards for a certain community. It can be assumed that standards are perceived to have a higher value and acceptance than a non-endorsed approach in the corresponding community. The above mentioned classes of approaches (process-, product-, and competency-orientation; generic vs. specific) can also be used for quality standards. Examples are given in Figure 1.

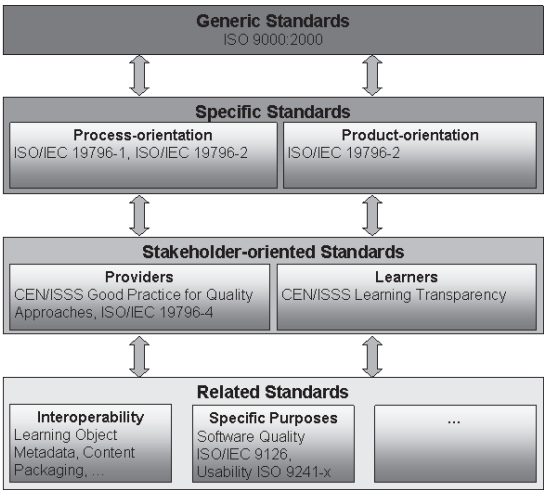

Figure 1: Classification and Levels of Quality Standards

Generic standards are domain-independent and have to be adapted to a specific context. The most used standard in this field is ISO 9000 (ISO, 2000). It is a generic standard for quality management of organizations. Because of its generic nature, the standard and its principles and methods can be applied to any type of organization. However, specific needs and specific characteristics for educational organizations have to be adapted with a high effort. As an extension to generic standards, stakeholder-oriented and related standards are used. *Stakeholder-oriented standards* provide support for specific groups to achieve quality by instruments such as guidelines or reference lists. *Related standards* do not cover the whole scope of quality management or assurance but address specific aspects such as usability or interoperability.

As generic standards need a high adaptation efforts when implemented in educational organizations, *specific standards* for knowledge-intensive organizations have been developed, in particular for learning, education and training. A specific approach has been recently developed for the field of IT-supported learning, education, and training ("E-Learning"). The standard ISO/IEC 19796-1 describes a "Reference Framework for the Description of Quality Approaches (RFDQ)" (ISO/IEC, 2005). Such a reference framework represents basic general and educational processes. As a process-oriented approach, it does not guarantee the quality of certain products (such as curricula) but provides a guideline how to organize the process to develop educational products. It gives an orientation which quality aspects should be covered and how solutions for these aspects can be found. Thus, the RFDQ could be applied as roadmap to design and implement an adequate solution consecutively. The standard is, therefore, an instrument to develop quality in the field of E-Learning. It consists of three parts:

- Description scheme for quality approaches
- Process model as a reference classification

- Reference criteria for evaluation

The model covers the main processes of a typical educational organization, in particular it contains reference processes for the development of learning, education, and training. The description model serves only as a kind of information-base to provide a harmonized scheme to describe quality approaches (Pawlowski, 2007). Table 1 shows the main processes.

Table 1: Process Model of ISO/IEC 19796-1

ID	Category	Description
1	Needs Analysis	Identification and description of requirements, demands, and constraints of an educational project
2	Framework Analysis	Identification of the framework and the context of an educational process
3	Conception / Design	Conception and Design of an educational process
4	Development / Production	Realization of concepts
5	Implementation	Description of the implementation of technological components
6	Learning Process	Realization and use of the learning process
7	Evaluation / Optimization	Description of the evaluation methods, principles, and procedures

This standard is a promising candidate as it already has specifically defined processes and criteria for educational organizations and has been developed by stakeholders in the E-Learning community.

Currently, a second standard is being developed in the above mentioned sub-committee of ISO/IEC. ISO/IEC 19796-2 "Harmonized Quality Model" (ISO/IEC, 2008) is a standard describing requirements for both, process- and product-orientation. In particular, it covers the main areas of educational organizations as we as categories for the evaluation of educational products (Figure 2). This forth-coming standard is a promising standard for both, organizational and product quality.

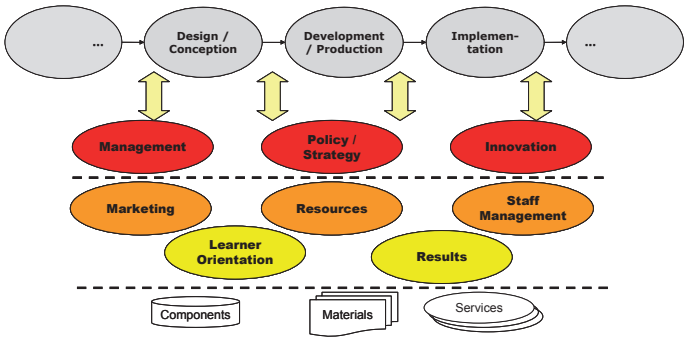

Figure 2: ISO/IEC 19796-2

As shown above, most standards require adaptation to a specific context. As an example, ISO/IEC 19796-1 is still a general framework, so it has to be extended regarding specific context. This regards the adaptation for *specific stakeholders* as well as specific *quality aspects*. Recently, the CEN/ISSS Workshop Learning Technologies has developed guidelines for providers as well as learners for different aspects: A guideline for choosing appropriate quality approaches for organizations (CEN/ISSS, 2007a) and finding appropriate learning resources (CEN/ISSS, 2007b). Those guidelines support specific quality aspects for specific stakeholders.

Finally, *specific quality objectives* have to be addressed depending on the context in an organization. As an example, interoperability can be seen as a specific quality objective. To achieve this, related standards such as Learning Object Metadata (IEEE, 2002) could be used. Further specific aspects could utilize standards from corresponding domains, such as ISO 9241 (cf. Bevan,

2001) for User Interface Design or ISO/IEC 9126 for Software Engineering (cf. Bevan, 2001). It is highly useful to validate whether similar standards can be transferred to the domain of education. However, this article focuses on the use of standards which are specific for knowledge-intensive organizations and education.

Summarizing the results, a variety of quality approaches is available currently for educational organizations. However, those have to be combined and implemented depending on the context and objectives of an organization. Therefore, an approach for the implementation is presented.

3 Adaptation of quality standards for OER repositories

In the following, an approach to implement and adapt existing standards will be described. The adaptation process is presented and illustrated for the case of Open Education Repositories.

The *Quality Adaptation Model (QAM,* Figure 3*)* follows a process in four steps (Pawlowski, 2007). These steps are not performed iteratively but should be individually schedules. Context Setting covers all preparatory activities for the adaptation process. Model Adaptation contains activities to implement the reference model based on the needs and requirements of an organization. Model Implementation and Adoption means the realization and the broad use of the quality system. Quality Development means that quality systems should be continuously improved and further developed.

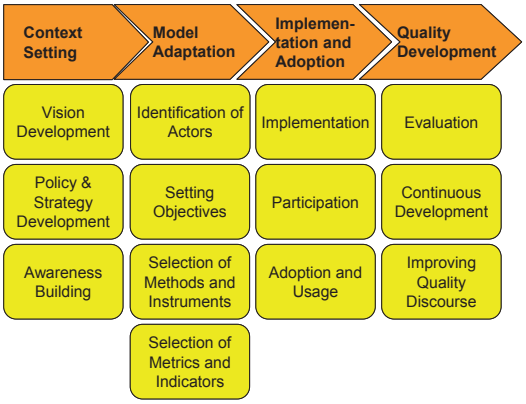

Figure 3: Phases of the Quality Adaptation Model

The focus of this paper is the choice and adaptation of standards for a specific context in a given setting.

Context Setting

The first phase initiates the quality development process and sets the context for quality development. It should ensure that quality development is launched and discussed in all parts of an organization. The organization's long term objectives, externally and internally, are contained in its vision, strategy, and policy. If an organization is committed to quality development, this should be contained in these statements. In most organizations, quality and specifically quality of E-Learning is not adequately represented. Therefore, the process to improve vision, strategies, and policies needs to be established (see Ittner, & Larker, 1997).

In the case of repositories, the organization is not always clearly defined – they are often run by consortia as results of projects. However, many stakeholders are usually involved. Therefore, it is necessary to include the main stakeholders. One form could be a quality management board. In any case, it is necessary to clearly define a quality policy which is continuously followed and validated.

Directly related is the process of awareness raising. Quality development will not be successful if it is a top-down regulation only. Quality development should be part of everyday operations and related to all activities. Therefore, all members of an organization should be aware of quality and its meaning for their personal actions. For the case of OER repositories, the context is different than in quality management process within just one organization. Awareness instruments should be available to all users, in particular as users only use the repositories for just a very limited time. On the methodological level, in addition to ex-ante quality assurance, continuous processes are needed as contents are added, changed and modified frequently (e.g., user-generated content). This means also that the quality instruments have to be different. Continuous, simple mechanisms (such as peer-reviews, rankings) should be promoted.

Model Adaptation

The second phase regards the process of choosing an appropriate quality approach or standard and to adapt this according to the context. This phase covers four main aspects. First of all, the *relevant actors* for quality development should be identified. It is useful to involve actors of all departments and all staff groups in this process. Actors, acting as multipliers for their groups should be involved. They should be fully committed to supporting the quality development process. The outcome of this phase is a list of actors responsible for quality. Usually, this also leads to changed responsibilities and tasks and which needs to be agreed with all actors. Secondly, the *processes* relevant for an organization should be identified. E.g., for producers of learning media, only some sub-categories (such as design and production) might be relevant. As another example, for tutors only the learning processes would be relevant. Additionally, processes specific for an organization should be added. The main step of adaptation is the *setting quality objectives* for each process. Quality objective means that for each process it should be defined how quality results can be achieved (e.g., process "technical concept": "the objective is to develop a clear, unambiguous specification of technologies used which meet the users' needs and preferences."). The quality objectives for each process cannot be defined by just one individual – they are subject to a negotiation process and should be agreed on in consensus with the relevant actors.

In case of repositories, these processes are not always clearly defined. However, typical processes (collaborating, searching / adapting / publishing resources, evaluating, cf. Pawlowski & Zimmermann, 2007) can be related to quality and corresponding instruments.

Based on the objectives, *instruments and methods* should be identified and selected. In this context these are concrete activities to achieve, assure, or assess quality for the given objectives. Examples of those instruments are benchmarking, assessments or simply the use of questionnaires. Instruments to achieve the quality objective "24 hour availability of the support hotline" could be an assessment of the call center's staff, test calls, or technical monitoring. The selection of adequate instruments is crucial for the success of a quality system: these instruments need to be adequate for the quality objective, the effort should be small, and they should be well accepted by the participants. Therefore, it is useful to inform and train staff members in the use and interpretation of these instruments.

As shown in the background section, instruments differ from other educational settings as the contents frequently change, users are not involved on a regular base. Therefore, a selection of instruments should be provided by the repository supporting this setting. A main idea would be to

create trust between users, organizations and towards resources. For repositories, the following instruments can be taken into account:

- **Quality management and assurance – trusted organizations and individuals:** Generic quality management mechanisms can rarely be implemented as the organizational form, stakeholders and content frequently change. However, some mechanisms can be considered when a repository is set up or periodically. The most promising mechanism is the recognition of quality certifications of participating institutions to create trust (Cummings & Bromiley, 1996, Dirks & Ferrin, 2001,): This means that organizations and individuals would be considered as *trusted*. In the use process, resources from trust organizations or people have a high probability to have a certain quality level which can be additionally assured by regular sample evaluations.
- **Review processes – trusted resources:** For certain resources, reviews are a mechanism to assure quality by the user community. However, not all resources can be reviewed every time they are changed. So this would be a mechanism to create trusted resources (cf. Jøsang et al., 2007) which would have a higher reputation.
- **Rankings and recommendations – swift trust:** As shown in section 2.1, these semi-automated mechanisms can be used for quality purposes. The idea is to provide recommendations to fulfill the users' quality needs and expectations and to create short-term swift trust (Järvenpää et al., 2004). This mechanism cannot guarantee quality but increase the probability to achieve a certain quality level. Rankings also help to identify low quality resources. Samples for this class of quality mechanisms are shown in the case study in section 4.

The selection of instruments is the most crucial aspect for repositories. There is currently no widely accepted solution for quality mechanisms. However, it can be recommended to use a mix of ex-ante quality mechanisms and simple, continuous mechanisms to support individuals and organizations.

Model Implementation and Adoption

The choice and adaptation are the first part of the implementation in which usually only small groups of actors are involved. This does not mean that every staff member should know the full quality system, but they should be aware of quality objectives for core and related processes they are involved in. To establish participation, there should be opportunities for actors to influence, change, and improve quality objectives and methods. Usually, the first implementation is done in representative test groups. Therefore, further users need to be involved and become familiar with the quality concepts to systematically broaden the use of the quality system. The outcome of this phase should be an implementation plan including activities to broadly adapt the model. In repositories, the process is on-going. In most cases, the implementation is the repository's owners responsibility. However, it is recommendable to have users involved in the process of implementing quality mechanisms.

Quality Development: Improving the organization's performance

A Quality System must be continuously evaluated, updated, and improved to be aligned to new developments in an educational organization. Therefore the following steps are necessary. The Quality System should be evaluated at least on a bi-annual base. Specifically, it should be evaluated if the quality system has led to overall improvements in the organizations performance. Furthermore, the adequacy of methods, instruments, and metrics need to be evaluated. Based on this evaluation, improvement actions should be taken, such as the change and refinement of the system's components. Again, for this phase a broad commitment and participation is necessary to reflect the staff's opinions and attitudes toward the system. This should lead to a broad awareness and

discussion on quality. For repositories, this is highly necessary, in particular, if the above mentioned recommendation mechanisms and rankings are used. The appropriateness of recommendations needs to be continuously evaluated and the mechanisms has to be improved.

As a summary, QAM provides the basic steps towards developing quality. For Open Education Repositories, such a model is of particular importance to plan the participation and involvement of users as well as developing and improving mechanisms to assure the quality of rapidly changing contents.

4 Case Study

In the following, we will illustrate the use of the Quality Adaptation Model (QAM) in a setting of an Open Education Repository. We show the basic idea of the COSMOS quality model based on existing standards. We conclude with results from the users' perspective.

The **COSMOS project** (Sotiriou, 2008) is a European project which has developed a repository, tools and templates to improve the (re-)use of Open Educational Resources (OER) for science education with a particular focus on astronomical resources. The challenge of OER projects and repositories in general is how to achieve and maintain quality of resources (cf. Downes, 2007) when these are freely available and being changed frequently by a community of users. Therefore, the following quality objectives are set:

- The quality of resources as well as didactical designs need to be assured by the stakeholders
- Validated, accepted standards are taken into consideration to incorporate existing experiences
- Quality mechanisms should be self-sustaining and easy to maintain
- All stakeholders should be involved and actively participating in the quality process
- The quality of the repository as well as resources should be continuously monitored and improved

Based on those basic quality objectives, it is necessary to find, adapt and implement standards fitting the needs of this context.

Context Setting

COSMOS' quality policy aimed at high-quality resources. As part of the strategy, a quality management group consisting of quality experts was installed, responsible for the continuous quality assurance process. Furthermore, it was decided that both, an initial ex-ante quality assurance as well as continuous mechanisms, should be part of the quality model. Besides this, *awareness raising* has been the most important issue. As in a typical European project, a variety of stakeholders is involved. In particular, a focus has been the awareness process for the future users, in particular teachers and teachers in training, who should be part of the quality assurance process: First of all, they participate indirectly by providing resources of a certain quality. Moreover, they contribute directly by reviewing and evaluating resources. This awareness raising was done by mainly face to face workshops with focus groups. The outcomes of this phase were the basic strategies regarding quality and initial discussions on quality with the focus groups. Finally, the

principle of trust was a key element of our approach. Creating trust towards different entities (organizations, individuals and resources) was the main goal.

Model Adaptation

In our case study in COSMOS, we combined the steps shown above. In the beginning, the requirements were discussed with relevant stakeholders: teachers, project managers, content providers and technical experts. Secondly, quality-relevant processes were identified using the standard ISO/IEC 19796-1. The main processes addressed are the design and development as well as the evaluation processes with a particular focus on the re-use and content adaptation processes.

Specific processes of the COSMOS repository and its use were identified. The main quality-relevant processes were 1) identifying the quality of newly published content, 2) peer-reviewing and marking reviewed content, 3) ex-ante evaluations from the stakeholder groups, 4) recognition of quality-assured organizations and 5) continuous quality assurance processes, such as peer-review and ranking processes. Based on those processes and requirements, we identified the main objectives and quality perspectives (**Error! Reference source not found.**):

- **Quality of organizations and individuals**: Firstly, COSMOS decided to create trust through organizational and personal quality certification. Based on the ISO/IEC model, organizations and individuals can be evaluated and join the group of quality experts. The COSMOS quality management group was responsible for these evaluations. Individuals then serve as quality representatives. Because of their experiences and previous certifications (e.g., ISO9000, accreditations, quality marks) they are aware of basic quality mechanisms and can later certify materials using the COSMOS approach. It should be noted that existing quality certifications (such as ISO 19796-1 or quality auditing skills) were accepted to avoid redundant certification processes. Secondly, active and committed users who have steadily submitted high quality materials can be awarded quality user status. This will enable them to act as quality representative within the portal.
- **Quality of materials**: For selected materials, COSMOS can offer to assess and certify quality. We use the approach of the ISO/IEC 19796-2 standard (ISO/IEC, 2008). This certification cannot be required for all materials but only for top-level quality materials as a unique characteristic.

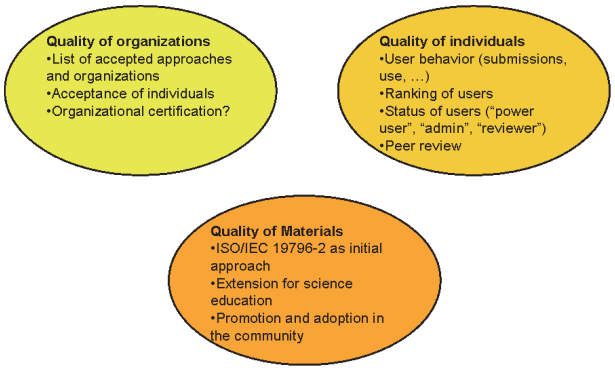

Figure 4: COSMOS Combined Quality Approach

By this combined approach of accepting existing quality standards (e.g., ISO 9000, ISO/IEC19796-1 and ISO/IEC 19796-2), we assure organizations as well as materials have a basic quality. On top of that, we introduce related quality approaches. This part is not based on quality standards but on

user-centered quality. We introduce rating and peer-reviewing systems to assure quality continuously.

Model Implementation and Adoption

In COSMOS, we decided to implement our quality approach in a step-by-step approach (see Figure 5). The main reasons for this are the different competencies and objectives of stakeholders.

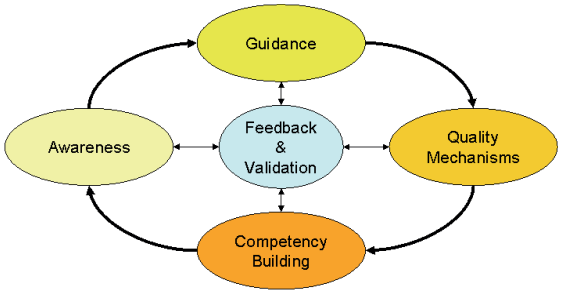

Figure 5: COSMOS Quality Process

In the first phase, the focus was awareness raising regarding quality. By online discussions and workshops, users started to pay attention towards the issue of quality and to raise their quality concerns.

The awareness phase was followed by providing guidance instruments and simple quality mechanism. We chose an approach giving responsibility for quality to the users. For this purpose, we provided firstly a developers guide and a user guide, based on the quality criteria of ISO/IEC 19796-2 and on the user guides of CEN/ISSS (CEN, 2007a, 2007b). Secondly, ex-ante evaluations were implemented. A quality board was selected to review selected resources which were considered as important for the community. However, this process cannot be realized continuously outside a project due to the lack of resources. Therefore, peer-review and commenting mechanisms were installed and highly used. Additionally, ranking mechanisms were implemented: Top rated resources, most contributing users, most re-used resources. As a further mechanism, we developed recommendations based on the context (e.g., subject domain, type of educational institution, age group) and trust towards users, organizations, and resources. Figure 6 shows the quality elements within the portal.

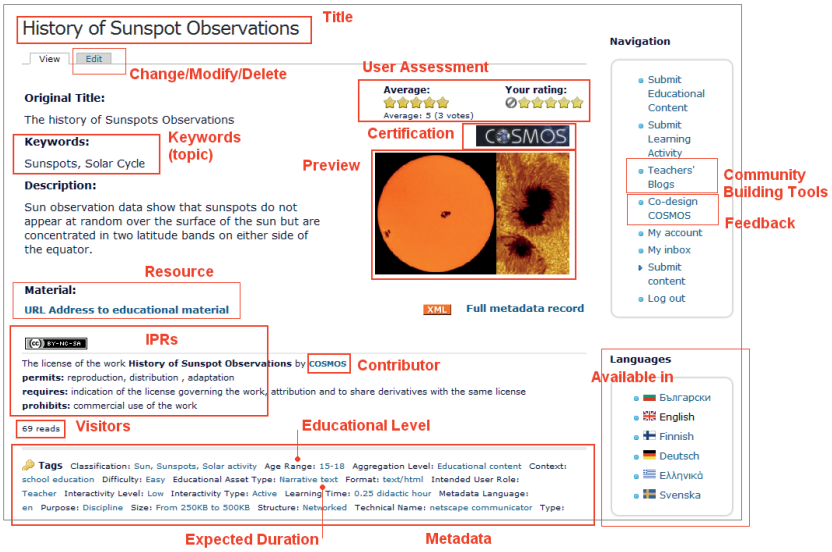

Figure 6: COSMOS quality mechanisms (Sotirious et al., 2009)

In the long term, we aim at continuously developing quality competencies of the stakeholders. This means that the self-responsibility of assessing resources and recognizing quality approaches will be increased.

Quality Development

The COSMOS case study has shown that the phases of the Quality Adaptation Model are a useful orientation for the implementation of quality standards. In our case, we have focused on the implementation and usage of existing quality standards which were described in the second section. The case study is limited in a way that the long-term effects regarding the given quality objectives have not yet been evaluated. The continuous quality development will therefore be continuously improved and validated.

Evaluation of the quality approach

We evaluated the approach in a study with the key user group, teachers (n=36). Those users had a variety of technical skills and most of them were aware and interested in the quality of resources as well as of organizations (Figure 7).

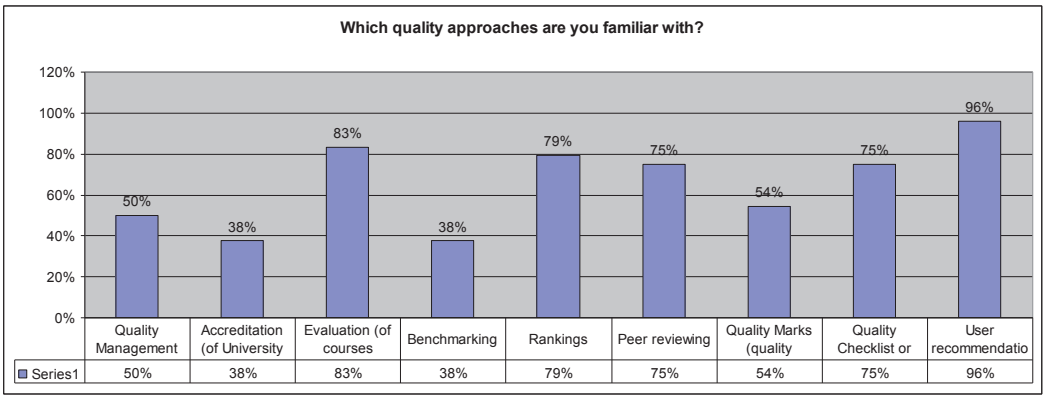

Figure 7: Quality Awareness and Familiarity (Sotiriou et al., 2009)

Users have perceived the approach positively in our evaluation. They have acknowledged the mechanisms and actively participated in peer-reviews and rankings. In particular, the relation of quality and trust became evident. Users explained that quality is based on how they trust different entities. In our interviews we identified the following aspects regarding trust (Sotiriou, 2009, Clements & Pawlowski, 2009):

- 79% of the interviewed trusted materials that came from an organization that has a good reputation. This proves the COSMOS Quality strategy part of giving the 'COSMOS' Quality certificate to the best resources.
- 71% trusted resources which had been evaluated by colleagues or scientists on the field. This proves COSMOS quality strategy on creating a group of Quality Representatives (Scientists on the Field) who evaluated the resources coming into the repository.
- 38% of the interviewed people trusted materials that had received good rankings. Cosmos Quality strategy served this set of users by allowing them to rank resources by giving them stars.
- 50% of the interviewed looked at the download ratings and how often the resource had been used by others when it comes to quality.
- 67% trusted resources, which came from an organization with a quality certificate.
- 50% trusted resources which were interoperable with their own Learning Management Systems.
- 46% trusted the full metadata records attached to a resource.

Overall this study proves that different users have different kinds of quality strategies and instruments as well as different perceptions and needs when judging the quality of the educational content. About 40% will be happy to trust simple user-based mechanisms such as rankings. However, another user-based method peer-reviewing is much more highly appreciated function. We also found out that about half of the people wanted to judge the quality of the resources themselves to be sure of their quality.

The study has shown that our approach of relating quality and trust in connection with guidance and simple mechanisms has been feasible and successful. However, some well-known quality

mechanisms (like organizational certification) still should be considered. However, the idea of recognition of external quality certificates can substitute own certifications or assessments.

5 Conclusion

In this paper, we have discussed quality for Open Education Repositories. Based on an initial classification, we discussed which approaches and instruments can help stakeholders to identify appropriate quality approaches for knowledge-intensive organizations. Secondly, the Quality Adaptation Model was introduced, in particular for the adaptation of approaches for repositories. It supports stakeholders in the selection and implementation process regarding quality standards. The model was illustrated using a case study approach. It was shown that the model helps stakeholders to organize the implementation process and to choose adequate standards for their context. The mixed approach of the recognition of widely accepted standards as well as simple mechanisms (such as rankings, reviews, recommendations) was proven to be successful for the presented setting.

6 Acknowledgements

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III

USER-ORIENTED QUALITY FOR OER: UNDERSTANDING TEACHERS' VIEWS ON RE-USE, QUALITY AND TRUST

by

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User-oriented quality for OER: understanding teachers' views on re-use, quality, and trust

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Abstract We analysed how teachers as users of open educational resources (OER) repositories act in the re-use process and how they perceive quality. Based on a quantitative empirical study, we also surveyed which quality requirements users have and how they would contribute to the quality process. Trust in resources, organizations, and technologies seem to be of particular importance when looking at quality. In our findings, we derive recommendations for learning object repositories and OER user-oriented quality assurance.

Keywords learning object repositories, open educational resources, quality, re-use, teachers, trust.

Introduction

How do users act when (re-)using open educational resources (OER)? Which quality factors do users see as important for OER? In this paper, we present an empirical study identifying user behaviour, attitudes, and requirements towards OER quality.

In the last 10 years, the number of OER, as well as their availability and distribution via learning object repositories (LORs), has rapidly increased. There clearly has been a general awakening in the e-learning community regarding OER (Downes 2007). More OER repositories are built, and metadata of existing repositories are harvested by federated repositories (Tzikopoulos *et al*. 2007) to improve access to high numbers of OER. This process brings critical masses of OER available to users, at the same time raising an increasing need for quality control of resources.

OER repositories need sustainable solutions (Downes 2007), also for quality assurance for large quantities of resources. It has been clearly identified that user community-based solutions could be the key of quality assurance providing the much needed volume for the reviews (Larsen & Vincent-Lacrin 2005). It is widely expected that the future quality of OER is assessed by learners and peers (Ehlers 2008). In 2007, 64% of OER repositories used a quality policy (Tzikopoulos *et al*. 2007). However, the instruments and approaches (including user-based) are very different and not well studied regarding their success (Pawlowski & Clements 2010).

We aimed at understanding how users act in the re-use process and how they perceived the quality of OER to derive sustainable future quality strategies. We reviewed current quality approaches for educational resources, as well as general quality approaches regarding their usefulness for OER quality. We analysed the quality of resources from the point of view of the stakeholders: does the resource meet the users' expectations and how does trust contribute to quality?

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Re-use of open education resources

OER

OER are not clearly defined in the community. United Nations Educational, Scientific and Cultural Organization (UNESCO) defines OER as 'technology-enabled, open provision of educational resources for consultation, use and adaptation by a community of users for

noncommercial purposes'. (UNESCO 2002) This is contrasted equivalent approaches such as open source (Raymond 1999) or open access (Björk 2004; Bailey 2005). Both established fields include commercial purposes. Davis *et al*. (2010) described educational resources as sets of resources that have been assembled and described with the intention that they could be picked up and re-used by others.

Harmonizing the above definitions, we see OER as all resources for the purpose of learning, education, and training that are freely accessible. This includes literature and scientific resources (open access for education), technologies, and systems (open source for education), and open content (actual learning materials/contents) as well as related artefacts (such as didactical materials or lesson plans).

Even though there seem to be many opportunities for stakeholders, the uptake and adoption of OER in educational practice is still low (cf. Ochoa & Duval 2009). Therefore, it is necessary to deeply understand why the re-use and adoption processes are not utilized as in similar communities.

Re-use

The process of creating learning materials from scratch can be made easier by the re-use of existing teaching and learning materials (Casey & McAlpine 2002). Downes (2007) describes re-use as 'integration into an existing content of use'. Littlejohn (2003) defined reusability of learning objects as 'availability of learning objects for others to use'.

We define re-use as using educational resources that have already been available via LORs for anyone's own purpose, needs, and context. We incorporate the possibility to modify resources and share those with the community leading to increasing amounts and qualities of resources for different contexts. In the context of this paper, we describe the process of re-use of OER for teachers to have the following five phases (see Fig 1, adapted from the resource adaption model in Pawlowski & Zimmermann 2007):

Fig 1 Re-use process for teachers re-using OER from LORs.

1 *Search phase*: Where and how can teachers find suitable resources for their use?
2 *Evaluation phase*: Are the resources suitable for the teachers' use? Are the resources adaptable for the intended context?
3 *Adaptation phase*: Modifying the educational resource to the use and context, mixing it with other resources.
4 *Use phase*: Using the newly adjusted resource in the needed context.
5 *Share phase*: Sharing the newly adjusted resource back to the community.

Phases 1–4 can be defined as simply using resources, and phase five extends those to advanced use. However, the number of these basic users is significantly higher than the users who modify and share. The re-use process phases 1–4 are familiar to teachers, and there is evidence in the community of teachers frequently re-using resources. This indicates there is no lack of interest in re-use, but rather, the technologies and communities around OER are not appropriate. A variety of barriers seems to keep users away from re-use (cf. OECD 2007; Pawlowski & Zimmermann 2007; Davis *et al*. 2010), such as critical mass of available content, lack of interoperability of repositories and tools, copyright problems, cultural differences, lack of motivation, and lack of quality of the content. However, it is not fully understood how these barriers are perceived by the users. In particular, the perception of quality is not analysed.

Quality approaches and standards

One of the most important concerns for OER is the perceived lack of quality. Quality can be defined as '[. . .] appropriately meeting the stakeholders' objectives and needs which is the result of a transparent, participatory negotiation process within an organization' (Pawlowski 2007a). Quality is not an objective measure but in particular a perceived value for stakeholders and their context. In general, three levels can be distinguished:

1 *Generic quality approaches* provide quality management or quality assurance procedures independent of the domain – examples are International Standards Organisation (ISO) 9000:2000 (ISO 2010) or the European Foundation for Quality Management

(EFQM) Excellence Model (EFQM 2009). When applied to a certain domain [such as technology enhanced learning (TEL) or specifically OER], these approaches need to be extended and adapted. Generic approaches contain domain-independent quality approaches and can generally lead to trust in certified organizations.

2 *Specific quality approaches* provide quality assurance procedures for the domain of TEL. An example is the ISO 19796-x standards series for educational organizations and educational resources (ISO/IEC 2009). Specific approaches aim at achieving high quality of certain products, e.g. at OER and related technologies. By applying certain quality approaches, a minimum quality is also achieved here. From a user's point of view, this also means increased trust in the products. Specific quality approaches differ in scope and methodology, ranging from quality marks for education (Pawlowski 2007b) to content development criteria (Leacock & Nesbit 2007) or competency requirements (Ehlers 2007).

3 *Specific quality instruments* aim at assuring quality for specific purposes, such as assuring the quality of metadata or rating contents. These instruments are sometimes embedded in broader quality approaches. Typical examples are ranking, peer review, or recommender systems.

All of those approaches can basically be applied to OER and repositories. It is important to analyse and understand three aspects:

1 *The effect of the quality approach*: as quality approaches aim at different objectives and scopes, it has to be clear which effects can be achieved with a quality approach. These effects have to match the users' needs and requirements.

2 *The perception of the stakeholders*: one important aspect is how users perceive quality. Even though lots of efforts might be spent for quality assurance, the value and the awareness of the users about quality is a main concern. It has to be clear which stakeholders benefit (e.g. learners, educators, publishers, technology providers, and policymakers).

3 *The cost of applying a quality approach* is of crucial importance in particular for OER. Most of the repositories are not commercial; thus, there is no budget for quality assurance tasks. This means that solutions need to be simple and cost-effective.

The main question is which approaches are feasible and promising when applied to OER and related processes and technologies. It is obvious that broad quality approaches cannot be required for participation of organizations and users in OER processes. Thus, the cost and sustainability aspects have the highest priority. As OER repositories need sustainable solutions (Downes 2007) for quality assurance, open source movements cannot rely on large quality assurance budgets – various community-controlled and automatic quality instruments have been put into place in LORs. User communities are seen as the key quality assurance task force – providing much needed volume for the reviews (Larsen & Vincent-Lacrin 2005). It is widely expected that the future quality of OER is assessed by learners and peers (Ehlers 2008). Users assure the quality of OER commonly by peer reviews, ratings, and recommendations. Various automatic recommender systems have become popular following amazon.com's successful example.

Peer reviewing can facilitate the task of evaluating quality of an OER in LORs. Peer reviewing is a time-consuming activity, and to do it properly requires some kind of management from the organization hosting the repository (Neven & Duval 2002). Various specific quality instruments can be seen as peer reviewing and it is an approach adopted by many LORs (e.g. MERLOT, ARIADNE & OER Commons), like rankings, commenting, social tags or the concept of peer production (Auvinen 2009), and/or making recommendations to other users in the community. However, use of quality ratings places significant responsibility on the community (Nesbit *et al*. 2002), which makes quality more cost-effective to achieve.

Recommender systems were originally defined as 'Systems that analyse the opinion of a community of users to indentify more effectively content for an individual' (Resnick & Varian 1997). However, the definition was later widened to 'any system that guides users with personal recommendations to interesting objects (Burke 2002). Recommendation systems can automatically guide users towards learning objects which they could find interesting based on various variables from their previous interests, similar user tastes (Goldberg *et al*. 1992) and download patterns to related contents. However, recommendation systems as all the specific

quality instruments are mostly successful in quality assuring the content if there is a strong enough community (Manouselis & Sampson 2004).

Trust and trust-based systems and mechanisms can be seen as a specific quality instrument. OER's quality is largely dependent on the authors of these learning objects, typically individuals from organizations. Observing the phenomenon of quality OER development, we looked into 'trust' as a key instrument in facilitating the process of re-use for teachers, especially the selection of OER. Our classification for the relationship of re-use, quality, and trust is that trust in (1) organizations; (2) individuals; (3) resources; and (4) technologies can facilitate the search of high-quality OER and therefore increase re-use of OER.

The definition of trust in literature is often vague. Rousseau and Tijoriwala (1998) describe trust as: 'a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another'. Others have used slightly altered definitions of trust more to the direction of trust as an expectation or belief that one can rely upon another person's actions and their good intentions (Johnson-George & Swap 1982; Robinson 1996; Zaheer *et al*. 1998). Peers have to manage the risk involved with the transactions without prior experience and knowledge about each other's reputation. (Xiong & Liu 2004) Trust can work as a substitute decision making instrument, in order to improve the quality of online markets. (Jøsang *et al*. 2007) In this research, we understand trust as belief of teachers being able to rely on certain OER through relying on individuals who created them or recommended them, or to rely on the organizations that these individuals belong to. However, we appreciate that as trust can mainly achieve quality by substituting the decision making process for users, trust only facilitates parts of the re-use process for users.

Trust has a number of important benefits for organizations and their members, Trust in organizations (Dirks & Ferrin 2001) means that resources from trusted organizations of individuals have a high probability to have certain quality level (Pawlowski & Clements 2010). However, trust does not automatically provide quality for the users – trust helps users to find resources of probable high quality, but still leaving themselves to make the evaluation on 'whether the resource is re-usable for the teacher's needed purpose and context. ' As OER and new versions of them are constantly uploaded to LORs, trust in all the resources is difficult to achieve. One option might be to create a set of trusted resources (Jøsang *et al*. 2007).

The following table summarizes our review of current quality approaches described (Table 1).

To summarize this analysis: both generic and specific quality approaches can be utilized but are not required for OER processes. However, some aspects have not been analysed so far, especially the users' perception of quality and the role of trust.

Methodology

The main goal of our study is to understand the phenomenon (Heidegger 1924) of re-use, quality, and trust as specific quality instruments. Our quantitative approach contained two surveys of which purpose was to test the relations between variables predefined by literature (Pinsonneault & Kraemer 1993; Yu 2003). In order to find out the users' views on quality, trust, and re-use of OER, we bring together results from two surveys conducted with European information and communications technology (ICT)/Mathematics teachers for secondary level education (teachers for students 15–19 years old). Along with learners, teachers are a key user group for OER re-use as many LORs specifically aim to provide educational resources for classroom use but also because many LORs share resources created by teachers, making teachers both the users and authors of OER. Surveys were used because we intended to gather information on the opinions of this particular group of people referred to as a population (Tanur 1982; Yu 2003). Surveys also allowed us to determine the values and relations of our key variables (Newsted *et al*. 1998). These surveys mainly consisted of multiple choice questions; however, open questions were also used to obtain further explanations of the answers. The survey questions were validated by pretesting with a small sample of focus teachers ($n = 4$) before the actual summer schools took place.

The response samples of these surveys consisted of teachers who participated in two summer schools organized by two European Union funded projects, Cosmos (Doulamis *et al*. 2008) and Aspect (Massart 2009). These teachers were selected by their own interest towards OER and LORs. The first survey ($n = 80$) included teachers from Lithuania, Portugal, Finland, Belgium, and Romania. The second survey ($n = 66$) also

Table 1. Quality approaches.

Approach	Purpose	Examples	Effect	Cost
Generic quality approaches	Concepts for quality management or quality assurance, independent of the domain of usage	• ISO 9000:2000 (International Standards Organisation 2010) • EFQM (European Foundation for Quality Management 2009)	Transparent quality of the participating organization Consistent quality of produced resources and technologies	High effort for organizations Only useful if organizations are certified independently of the OER engagement
Specific quality approaches for TEL	Quality management or quality assurance concepts for the field of learning, education, and training	• BLA Quality Mark (British Learning Association 2005) • QAA Framework Consortium for Excellence in Higher Education (Higher Education Founding Council for England 2001). • Quality on the Line Benchmarks Institute for Higher Education Policy (Phipps & Merisotis 2000) • ASTD Quality Criteria American Society for Training & Development (ASTD 2009)	Assurance of organizations and TEL products: assured quality of resources	High effort for resource quality assurance Cannot be required for OER engagement
Specific quality instruments	Manage or assure specific aspects of quality	• Ratings (Nesbit *et al*. 2002) • Recommender systems (Manouselis & Sampson 2004) • Peer reviews (Neven & Duval 2002) • Trust (Pawlowski & Clements 2010)	Assurance of specific quality aspects	Low efforts for most instruments; some instruments can be automated; can be achieved as part of community engagement

OER, open educational resources; TEL, technology enhanced learning.

included teachers from these countries but additionally from Austria, Sweden, Greece, United Kingdom, Bulgaria, Turkey, and one teacher from Ethiopia. Fifty-seven per cent of the overall teachers were male, and 43% were female. Most of them (55%) were over 40 years old and therefore had more than 10 years of teaching experience. Twenty-seven per cent were in their thirties, and 23% were in their twenties. No particular skills of ICT were requested of the teachers. However, the teachers were observed to be more ICT literate than average teachers in Europe, which should be taken into consideration when assessing these results. According to their responses, 79% of these were using computers several hours per day, and they were familiar with advanced teaching by computers such as blogs, wikis, and learning management systems (LMSs). ICT literate teachers interested in OER can be seen as representative of teachers using repositories, making this responder group relevant for our study. The summer schools were chosen as a test bed in order to make sure that all teachers had an understanding in basic concepts of OER, LORs, and quality mechanisms. The sample groups can give an indication of the users' views on issues researched, but cannot be generalized for the whole European teacher community as the backgrounds, skills, and interests of the teachers can vary greatly in Europe. The survey answers were gathered via digital forms (Dommeyer *et al*. 2004). The response rate covered the whole sample as these teachers were participating in a particular event, and this could be achieved.

Surveys: results and discussion

In this part, we present the descriptive results from the surveys and discuss their effect on the previously described research on the field.

Firstly, we asked the users to describe their *ways of searching* for OER.

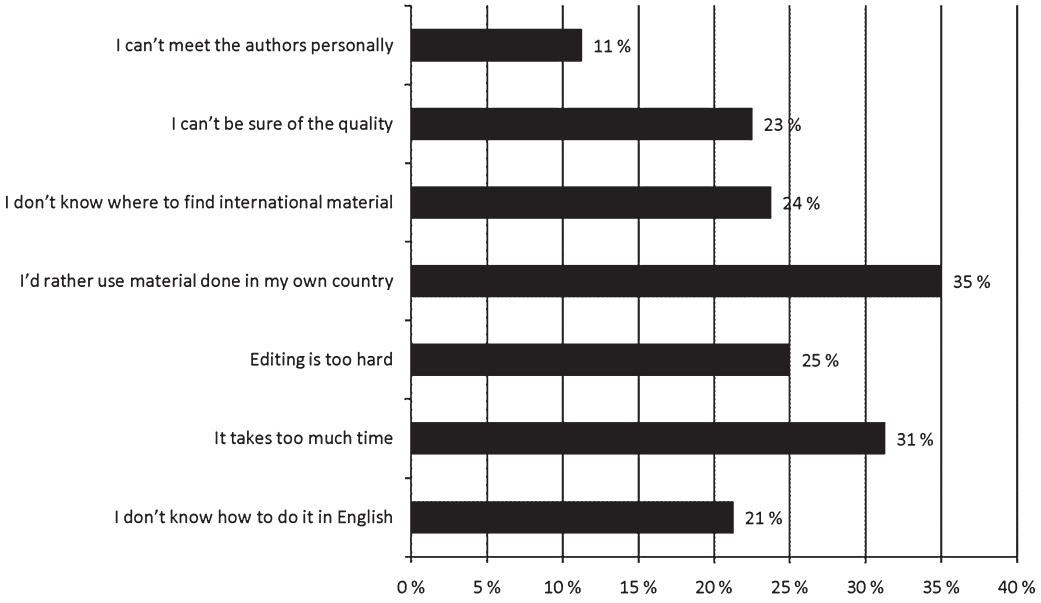

Fig 2 Barriers of re-use (phases 1–4 of the re-use process) for teachers.

- Eighty-nine per cent found resources by *browsing on topics and subjects*.
- Eighty-two per cent found resources based on *recommendations from colleagues*.
- Seventy-one per cent found resources based on *recommendations from personal friends*.
- Fifty-six per cent searched for well *ranked* resources.
- Fifty-eight per cent searched for resources that come from an *organization with good reputation* (such as Harvard, MIT, and NASA).

Even though browsing by topics is still the most common way to find resources, most users look into trust mechanisms as recommendations from colleagues, personal friends, or organizations that have a good reputation. This indicates that trust really influences the search phase of the re-use process, and there is also evidence that quality instruments such as rankings and recommendations can facilitate the search process as expected in literature (Nesbit *et al*. 2002; Larsen & Vincent-Lacrin 2005; Ehlers 2008).

Users found relatively little *simple re-use barriers* (phases 1–4, see Fig 2), which can be seen as promising. Some teachers identified time, language, culture, and quality as problems when using OER made by others.

However, more problems were identified when asked about *advanced re-use of OER* (sharing) with international LORs. This supports the notion that many users are just conducting the simple re-use (phases 1–4), but not sharing modified resources back to the community. This finding confirms Ochoa and Duval's (2009) notion that '[. . .] how the contributor benefits from contributing to the repository is still an unsolved issue in most repositories'.

Major barriers of sharing recognized by this study were curriculum compatibility problems (74%), copyright problems (52%), and subject/topic variation between countries (48%) (Fig 3). Minor worriers of teachers included cultural problems of communication, didactics, roles of teachers and students, and interface differences. These findings confirm barriers derived from OECD (2007); Pawlowski and Zimmermann (2007); Ochoa and Duval (2009); and Davis *et al*. (2010) to be actual and relevant in the teachers' point of view.

When asked which kind of *LOR functionalities* could help the teachers to increase re-use of OER, 55% of the teachers thought that reviews and evaluation would help them. Teachers did not see rankings/ratings helping them much in the re-use of OER; only 26%

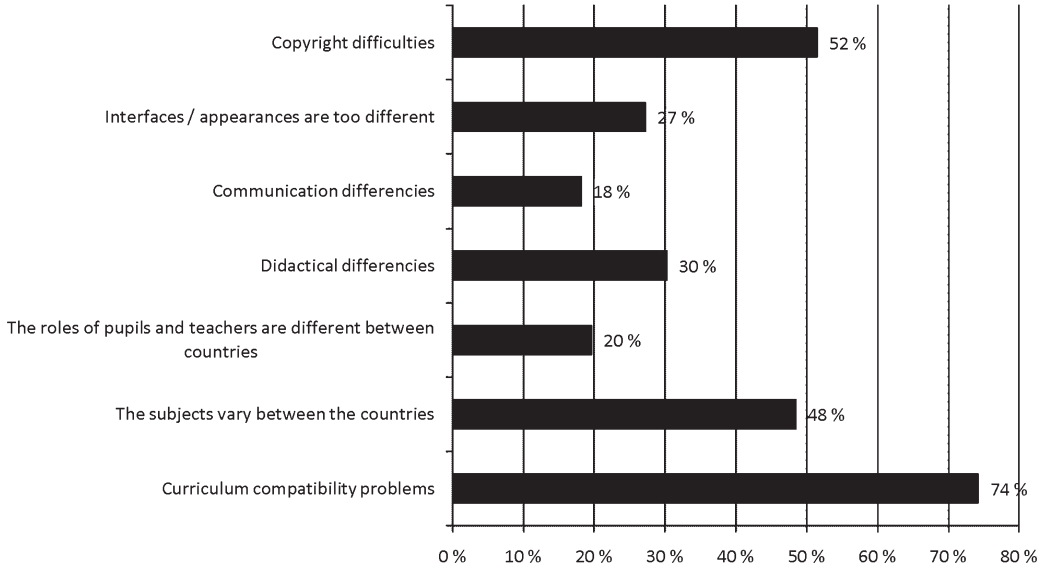

Fig 3 Barriers of sharing OER (phase 5) in an international LOR for teachers.

found them helpful. This notion supports our hypothesis that rankings/ratings (Nesbit *et al*. 2002) possibly can only help teachers to search and evaluate resources, but quality instruments such as rankings cannot help the phases 3–5 of the re-use process. Most popular functionalities included an efficient search tool (69%) which indicates that the teachers have problems of locating resources in the web. Eighty per cent wished that resources would be easy to use, and 70% needed them to be easily adopted for their lessons. Around half of the teachers thought that reliable resources would increase re-use. This shows that user-based quality instruments such as ratings might not be enough to create trust on LORs and OER in them, and that the teachers need concrete measures to improve the quality and increase re-use of OER – easy to use and adaptable resources that they can trust to find efficiently will make a successful case of re-use. Visual appearance and rankings are not enough as Davis *et al*. (2010) indicated. Translations help more than half to re-use OER, so do keyword indexes and metadata attached to the resource or its link.

In order to determine which quality approaches the teachers were aware of, they were asked about the three types of quality described in the previous chapter: generic quality, specific approaches for TEL, and specific quality instruments. Teachers' awareness on these approaches was limited. Teachers were mainly familiar with specific quality instruments, which is only natural as they would have gotten familiar with them when using LORs. Specific quality approaches for TEL were slightly less known; for example less than a third of them knew about benchmarking. Forty-five per cent of the teachers claimed to be familiar with generic quality approaches such as ISO 9000 or EFQM. Teachers' awareness on quality approaches is presented in Fig 4. We can conclude that there is a significant lack of awareness on quality approaches from the point of view of the teachers, which might affect their ability and motivation to contribute towards user-based quality instruments, even though they are seen as a significant quality assurance task force (Larsen & Vincent-Lacrin 2005) and it is expected that future of quality is assessed by peers (Ehlers 2008).

In this study, we also investigated what *quality of resources* means for the users.

- Eighty-three per cent of the users described the quality of resources to mean that the resources had a *good use of multimedia* (animations and simulations), which points to the need to find more complex educational

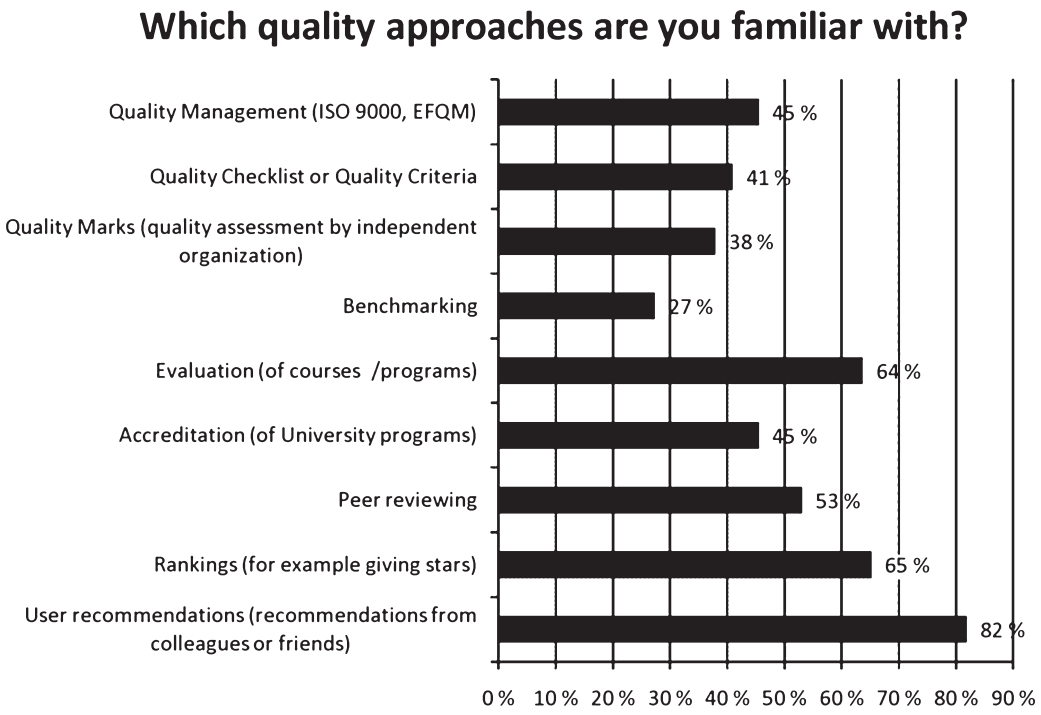

Fig 4 Teachers' awareness on quality approaches.

resources. A quality resource for this group of teachers is something that is complicated to produce, perhaps something that they could not produce themselves.

- Eighty per cent of the teachers defined quality of resources as *scientifically correct*.
- Seventy-nine per cent of the users said that quality of resources means they *fit their lessons or curriculum* of their country.
- Sixty-eight per cent found quality of resources to mean *interoperability* between the LOR and their LMSs.
- Fifty-five per cent of the users said that quality resources come from an organization with a good reputation (e.g. CERN, Harvard, and NASA).
- Seventeen per cent of the users said they have their *own quality strategy*.

Users were also asked questions regarding their *trust* in the context of OER.

Eighty-five per cent said: 'I trust organizations with good reputation'.

Fifty-five per cent said: 'Quality for me means that the resources come from an organization with good reputation'.

This indicates that there is a strong connection between trust and quality. However, users still have to review educational resources themselves to know that they are high quality (73% said this). This finding supports Järvenpää *et al*.'s (2004) finding that 'although trust can eliminate various process losses, trust does not necessarily result in an improved task outcome'.

Users also trusted quality instruments such as good ratings (67%), use-rates (53%), and peer reviews (70%), as well as generic quality approaches such as ISO 9000 or EFQM (74%). Half of the teachers said they would trust resources based on their interoperability between LORs and their own LMSs, which confirms that trust in technologies is a contributing factor of OER trust.

Davis *et al*. (2010) argue that the more users are involved in the quality process of OER (commenting, recommending, tagging, and rating), the more they will trust the LOR. Engagement of activities builds trust in

the effectiveness of the system, making the users feel comfortable to invest their time. It would seem that user-based quality approaches do not only make quality assurance more manageable in terms of costs, but will also motivate users to re-use.

As rising from the literature review, LOR quality assurance can only be sustainable if user communities get involved (Larsen & Vincent-Lacrin 2005). 48% to 71% of users were willing to contribute via user-based quality instruments. Seventy-one per cent were willing to conduct peer reviews according to quality guidelines or rank resources by giving the resources stars. Sixty-seven per cent said they would be willing to briefly comment on resources, whereas almost half said they could think of becoming an accredited reviewer and would like to get their organization certified by quality management standards and/or quality marks. *Users' interest to contribute to quality management* is in line with their awareness on the approaches; specific quality instruments were considered popular ways of contributing, as they were also the approaches that the users were most familiar with.

Teachers were also asked of possible *barriers of contributions*. The most typical problem was lack of knowledge when it comes to the quality of resources (45%), whereas lack of time was only seen as a problem by 27% of the teachers. Forty-one per cent said they think that quality depends on the situation of use, which would mean that they would not feel comfortable evaluating without known context. Only 5% did think that quality could not be assured at all. These results show that teachers have positive attitudes towards user-based mechanisms.

Conclusions & future work

In this study, we deeply analysed the current literature of OER quality and trust approaches. Based on the literature, we outlined our empirical study to explore the views of teachers as the key stakeholder group. Our study confirmed many statements based on previous literature from the point of view of teachers, specifically that:

- Users take recommendations into consideration when searching and selecting OER.
- Some users have problems when it comes to international resources, especially when adopting resources to their own purpose takes too much time.
- Most severe problems recognized in an international re-use context were cultural: curriculum compatibility and copyright problems.

We also researched quality and specifically trust as a specific quality instrument and made the following new findings from the point of view of teachers:

- Trust is a key quality instrument.
- Trust facilitates re-use of OER, especially the 'search and evaluation' phases (1–2) of the re-use process.
- User-based specific quality instruments (such as peer reviews, rankings, and recommendations) can improve the quality of LORs from the point of view of the teachers; however, the users and communities using these instruments are yet lacking enough motivation to contribute towards quality in many cases.
- Teacher's awareness on quality approaches is still limited.
- Teachers are willing to contribute towards quality of OER by ranking, commenting and recommending, or even becoming accredited reviewers.
- Creating trust for different users needs different approaches (e.g. some trust organizations with good reputation; others trust technologies or their personal friends).

Our recommendation is to raise awareness of the re-use and quality approaches in user communities. Many teachers will also require more training in using LORs and specific re-use tools to match their ICT skills to enable everyday re-use of OER. Raising awareness and involving users into quality assurance will motivate them to re-use OER from existing repositories. Also, our recommendation is that user-based quality approaches for existing LORs should be studied from the point of view of their success. Even though we have analysed the users' views and intentions, this does not automatically lead to active, participating users as seen in other domains (Kittur *et al*. 2007). Thus, the analysis of realized effects of user communities and social networks for making re-used LORs successful needs further analysis. If user communities can assure the sustainable quality of LORs and increase re-use, how does a LOR community evolve into a successful, trusted place for re-use?

Finally, we can state that our study has provided a survey of current research and insights into the phenomenon of OER re-use and quality for teachers.

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IV

OPEN EDUCATIONAL RESOURCES REPOSITORIES LITERATURE REVIEW - TOWARDS A COMPREHENSIVE QUALITY APPROACHES FRAMEWORK

by

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Open educational resources repositories literature review – Towards a comprehensive quality approaches framework

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ABSTRACT

Today, Open Educational Resources (OER) are commonly stored, used, adapted, remixed and shared within Learning object repositories (LORs) which have recently started expanding their design to support collaborative teaching and learning. As numbers of OER available freely keep on growing, many LORs struggle to find sustainable business models and get the users' attention. Previous studies have shown that Quality assurance of the LORs is a significant factor when predicting the success of the repository. Within the study, we analysed technology enhanced learning literature systematically regarding LORs' quality approaches and specific collaborative instruments. This paper's theoretical contribution is a comprehensive framework of LOR quality approaches (LORQAF) that demonstrates the wide spectrum of possible approaches taken and classifies them. The purpose of this study is to assist LOR developers in designing sustainable quality assurance approaches utilizing full the potential of collaborative quality assurance tools.

1. Introduction

For the last two decades, a rapidly growing amount of Open Educational Resources (OER) has become available in Learning objects repositories (LORs) for educators to re-use, re-publish and share within their communities, supporting collaborative learning (Dimitriadis, McAndrew, Conole, & Makriyannis, 2009). Smaller OER repositories are built into federated repositories by being harvested for their metadata to improve access to higher numbers of learning objects (Tzikopoulos, Manouselis, & Vuorikari, 2007). Unfortunately, these repositories are not used up to their full potential (Dichev & Dicheva, 2012; Mitchell & Lutters, 2006; Ochoa & Duval, 2009). Thousands of digital resources are created collaboratively and published online every day, and their quality control, assurance and evaluation are of paramount importance for potential users (Downes, 2007; Palavitsinis, Manouselis, & Sánchez-Alonso, 2013). OER enable forms of collaborative learning (Dillenbourg, 1999) and LORs of today can be considered as computer supported collaborative learning (CSCL) environments as they provide users tools for posting knowledge productions into a shared working space and providing tools for progressive discourse interaction between the users (Scardamalia & Bereiter, 1994). Adding social and collaborative features has been a recent trend of LORs to facilitate wider user engagement (Monge, Ovelar, & Azpeitia, 2008; Sánchez-Alonso, Sicilia, García-Barriocanal, Pagés-Arévalo, & Lezcano, 2011).

According to previous studies (Attwell, 2005; Barton, Currier, & Hey, 2003; Clements & Pawlowski, 2012) quality of OER plays a significant role in the success of the open content repositories (LOR) (Cechinel, Sánchez-Alonso, & García-Barriocanal, 2011; Tate & Hoshek, 2009). Therefore, it is vital to study LORs quality approaches (Clements, Pawlowski, & Manouselis, 2014) in a systematic way. Previous literature reviews on LOR quality approaches have focused on metadata quality only (Palavitsinis et al., 2013) and in the case of Atenas and Havemann (2014) have defined quality approaches quite simply as any approach which might attract users' to re-use content. However, this is the first systematic LOR quality approaches literature review which looks at quality management as a holistic approach around the repository, not only focusing on the quality instruments but also policies, standardization and pre-publication related quality approaches. This literature review puts emphasis towards collaborative tools such as peer review (Neven & Duval, 2002), which contribute towards the quality assurance of the repository. CSCL is an emerging research field that focuses on how collaborative learning, supported by technology, can enhance peer interaction and work in

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groups, and how collaboration and technology facilitate sharing and distributing knowledge and expertise among community members (Lipponen, Hakkarainen, & Paavola, 2004).

Learning object repositories quality approaches have previously been classified as (Pawlowski & Clements, 2010):

1. The Generic Approach of Quality standards (e.g. ISO 9000 standards (Stracke, 2009), European Foundation for Quality Management Excellence (European Foundation for Quality Management, 2014).
2. Specific Quality Approaches (e.g. Content development criteria or competency requirements) (Leacock & Nesbit, 2007).
3. Specific Quality Instruments (e.g. user generated collaborative quality approaches such as rating (Nesbit, Belfer, & Vargo, 2002), peer review (Neven & Duval, 2002) or recommender systems (Manouselis, Kyrgiazos, & Stoitsis, 2014).

In this study, we investigated quality approaches for LORs with a systematic literature review (Kitchenham (2004)) in order to understand the holistic phenomenon of quality assurance comprehensively and to form a quality approaches framework which LOR developers can take into account when designing new repositories as well as improving the quality of the existing ones. The classification above was used to guide our review process as the starting theoretical framework.

This paper is organized as following: In the second section, we describe the main concepts of educational resources and learning object repositories. In the third chapter we define quality approaches around repositories. Chapter four describes the literature review methodology and systematic mapping of quality approaches. Chapter five presents the analysis of the results and the learning object repositories quality assurance framework (LORQAF). The paper concluded with a summary of results clarifying the contributions of this study for theory and practice.

2. Theoretical background

2.1. Open educational resources

Downes (2007) describes Open Educational Resources (OER) as: "In the system implemented by Creative Commons (widely thought to be representative of an "open" license) authors may stipulate that use requires attribution, that it be non-commercial, or that the product be shared under the same license. According to Wiley and Edwards (2002) a learning object is "any digital resource that can be reused to mediate learning." OECD's (2007) definition was: "Open educational resources are digitized materials offered freely and openly for educators, students and self-learners to use and reuse for teaching, learning and research". Very popular definition of OER is by UNESCO (2002) defining OER as "technology-enabled, open provision of educational resources for consultation, use and adaptation by a community of users for non-commercial purposes". Davis et al. (2010) described educational resources as sets of resources, which have been assembled and described with the intention that they could be picked up and re-used by others. Harmonizing the previous definitions, this study defines OER as "All resources for the purpose of learning, education and training which are freely accessible for the user". In the context of this paper, we recognize that educational resources' synonyms from the technology enhanced learning literature include: 'learning objects, digital resources, digital content, digital resources, reusable learning objects, educational objects, educational resources and educational content'. Digital resources can be shared, re-used and collaboratively created across different countries and cultures (Laurillard, 2008). Open educational resources can support collaborative learning particularly well because they have been designed to be enhanced and repurposed and therefore can support cognitive processes behind collaborative learning (Dimitriadis et al., 2009). OER also provide opportunities for long term collaboration and partnerships beyond people's daily context (Pirkkalainen & Pawlowski, 2014).

OER's significant milestone in its history was MIT's OpenCourse Ware Initiative (Abelson, 2008) where large amount of courses were made freely available. After MIT's example, many institutions have followed the policy of giving out course materials for free – selling the diplomas or graduation certificates. This way OER can work as a marketing tool for the institute's recruitment. OER certainly have been accepted in the community, but face the common problems of the 21st century: Information is in such large quantities – how to get the teachers' attention towards these materials? In order for OER to be re-used, they have been most commonly gathered into databases that are linked to a user interface portal. This is called a Learning object repository.

2.2. Learning object repositories

LOR are multi-functional platforms which are designed to facilitate access to reusable learning objects in a variety of formats, so users can search for, find and make use of this content (Downes, 2001). Learning object repositories can also be defined as digital databases that house learning content, applications and tools such as texts, papers, videos, audio recordings, multimedia applications and social networking tools (McGreal, 2011). The purpose of a repository is not simply safe storage and deliver resources, but allow their administration in terms of updating, identifying, utilizing, sharing and re-using them (Retalis, 2005). OER creation also provides potential for teachers and educators for co-creation and collaboration, which are processes that state-of-the-art LORs try to support through social networking features (Okada, Mikroyannidis, Meister, & Little, 2012). Although such LORs using social software for collaborative learning and teaching raise barriers for users in areas like cultural distance and lack of quality (Pirkkalainen, Jokinen, Pawlowski, & Richter, 2014). Some popular examples of LORs include: Le Mill,[1] OER Commons[2] and KlasCement.[3]

McGreal (2008) classifies learning object repositories into three basic types:

1. Centralized model with content stored on the site.
2. Portals that mainly store links and metadata to materials provided by others.
3. Repositories with equal role as a content provider and portal.

McGreal's (2008) study has been widely used as it identified the principal functionalities of LORs as: search/browse OER, view OER, download OER, store OER and download OERs metadata.

Another type of classification is based on the nature of the content and content providers: Learning object repositories might contain resources from a certain topic (thematic repository). Many ministries of education have their own nation-wide portals for all topics (National repository). LORs which harvest metadata from other repositories are called 'Federated repositories' (Clements et al., 2014).

General characteristics of well known LORs were studied by Tzikopoulos, Manouselis, and Vuorikari (2009). Their investigation covered features such as educational subject areas covered, metadata, standard used, LOs availability in different languages, quality

[1] http://lemill.net/.
[2] https://www.oercommons.org/.
[3] http://www.klascement.be/.

Table 1
Quality classification (Clements & Pawlowski, 2012).

Approach	Purpose	Examples
Generic quality approaches	Quality standards present concepts for quality management, independent of the domain of usage	ISO 9000:2000 (ISO, 2014) EFQM (European Foundation for Quality Management, 2014)
Specific Quality approaches for TEL domain	Quality management or quality assurance concepts for the field of learning, education, and training, top-down approach	QAA Framework Consortium for Excellence in Higher Education (Higher Education Founding Council for England, 2001) Quality criteria (Pérez-Mateo et al., 2011)
Specific quality instruments	User generated quality mechanisms for managing specific aspects of quality, bottom-up approach	Ratings (Nesbit et al., 2002) Recommender Systems (Manouselis, Drachsler, Verbert, & Duval, 2013) Peer reviews (Neven & Duval, 2002) Trusted networks approach (Clements & Pawlowski, 2012)

control, evaluation mechanisms and intellectual property management. This study provided an overview about LORs' current development status and popular features that they incorporate.

Ochoa and Duval (2009) provided a comprehensive quantitative analysis of LORs' growth and usage, in which was discouraging to notice that LORs struggle to keep their users coming back to them, specifically if they were built on project funds – many have trouble extending their community after the initial funding ends.

In a recent study, Zervas, Alifragkis, and Sampson (2014) analysed 49 major repositories functionalities, but also published the details of common repositories' user and content amounts. Most project built repositories don't seem to reach the masses of users and their user base remains in a few thousand. In Zervas et al.'s analysis, only two repositories reached over a 100 000 users, Merlot[4] (118.874 users) and Curriki[5] (387.189 users). By far the biggest amount of learning objects are within the federated repository system of Ariadne[6] (830.297 LOs). Information was from February 2014. This study also found out that current LORs' implementation adopts mainly functionalities that are related to the basic functionalities of LORs, whereas functionalities related to the added value services (such as social collaboration tools as well as evaluation tools) component are limited. This provided us with evidence that current LORs are mainly developed for facilitating the storage and retrieval of LOs, whereas functionalities for facilitating collaboration between teachers and learners when using LOs available in LORs are rarely supported, even though repositories have for quite some time already been trying to move towards supporting collaborative learning (Monge et al., 2008). Previous studies have observed that LORs oriented towards the generation of content should also consider quality assessment and not just constrained to content and furthermore, being opened to the entire process of collaborative construction of new knowledge (Pérez-Mateo, Maina, Guitert, & Romero, 2011).

3. Quality approaches for LORs

Quality can mean different things to different people in different contexts (Clements et al., 2014). We should study quality as a phenomenon, which is part of a given community of practice and a specific product (Ochoa & Duval, 2009). ISO 9000 (2014) standard defines quality as the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs. Quality can also be defined as "[...] appropriately meeting the stakeholders' objectives and needs which is the result of a transparent, participatory negotiation process within an organization." (Pawlowski, 2007). In the context of OER and LORs quality can for example mean that teacher finds a suitable resource for his/her teaching.

[4] http://www.merlot.org/merlot/index.htm.
[5] http://www.curriki.org/.
[6] http://www.ariadne-eu.org/.

LORs typically have significant problems with the quality of the resources (Pawlowski & Zimmermann, 2007; Pérez-Mateo et al., 2011). Previous studies on LOR have highlighted the issue of quality assurance of repositories, as this is seen as key to provision of quality content to end users (Manouselis & Costopoulou, 2006; Atenas & Havemann, 2014; Petrides, Nguyen, Jimes, & Karaglani, 2008). In this study we look at the quality of LORs not only from the perspective of the quality of the OER, but from the perspective of the repository and the services around it.

Quality approaches classification (Clements & Pawlowski, 2012) is presented in Table 1.

3.1. Generic quality approaches

Generic quality approaches provide quality management or quality assurance procedures independent of the domain. When applied to a certain domain (such as Technology Enhanced Learning or OER), these approaches need to be extended and adapted. Generic approaches contain domain-independent quality approaches and can generally lead to trust in certified organizations. If an organization uses for example the EFQM excellence model, it is assured that all products have been assessed and quality controlled. From a user's point of view, this means that the trust in organizations and thus their products can be increased. While the EFQM-Model is used for self-assessment, the ISO 9000 is used to prove organizations by external assessment to earn a seal of approval (Ehlers & Pawlowski, 2004).

3.2. Specific quality approaches

Specific quality approaches provide quality assurance procedures for the domain of Technology Enhanced Learning. Specific approaches aim at achieving high quality of certain products, e.g. at OER and related technologies. By applying certain quality approaches, also here a minimum quality is achieved. Specific quality approaches differ in scope and methodology, ranging from quality marks for education (Pawlowski, 2007) to content development criteria (Leacock & Nesbit, 2007) or competency requirements (Ehlers, 2009).

Specific quality approaches also include outsourcing the evaluation of the OER for external experts (Nielsen, 1994). This might be the most reliable way of judging OER quality, however most LORs do not have a sustainable way of hiring experts, which is why they rely on specific quality instruments which bring in quality assurance through crowd sourcing.

3.3. Specific quality instruments

Not all problems of quality can be addressed effectively by machine solutions (Barton et al., 2003). Specific quality instruments (Atenas & Havemann, 2014; Hylén, 2006; Pawlowski & Clements, 2010) are commonly known as technological features

in the repositories, through which the community of users generate their own quality assurance either directly (rating, reviewing, commenting, flagging etc.) or indirectly (The LOR portal can monitor the users' activities and based on that social data, make automatic promotions of content (recommendation systems). Vargo, Nesbit, Belfer, and Archambault (2003) proposed an evaluation instrument called "LORI" for peer reviewing and commenting on learning objects. LORI (version 1.3) included the measures 10 separate qualities of learning objects including:

1. Presentation: aesthetics
2. Presentation: design for learning
3. Accuracy of content
4. Support for learning goals
5. Motivation
6. Interaction: usability
7. Interaction: feedback and adaptation
8. Reusability
9. Metadata and interoperability compliance
10. Accessibility

As OER repositories need sustainable solutions for quality assurance (Downes, 2007), specific quality collaborative instruments have become increasingly popular. Unfortunately, in voluntary settings in OER communities, it is not easy to find adequate motivated reviewers unlike in fields like e-commerce. Specific quality instruments can only work with a strong community behind them (Davis et al., 2010). LOR developers favour specific quality collaborative instruments because they are cost-effective, however, they are problematic also because of the context nature of quality.

4. Methodology

This study is motivated by the following objective: To perform a systematic literature review on quality approaches and success measuring of learning object repositories. The goal of the analysis was to answer the following research questions:

1. What kind of approaches & instruments do learning object repositories use for managing their quality?
2. How to classify quality approaches for LORs?
3. Which kinds of characteristics do the approaches have?

The literature review for the quality approaches was conducted using the systematic approach by Fink (2005) as method to describe available knowledge for professional practice. The rigorous approach should be *systematic* with clear methodology, *explicit* in the procedures, *comprehensive* in the analysis and *reproducible* by others (Fink, 2005). The literature review followed the steps defined by Kitchenham (2004) for conducting a rigorous analysis. The steps include: (1) Identify need and define the method, (2) create research question(s), (3) conduct the search for relevant literature, (4) assess the quality and appropriateness of the studies, (5) extract data from the studies, (6) conduct data synthesis and finally (7) interpret the results and write a report.

During the literature analysis, we used synonyms of OER and LORs (defined in chapter 2) in order to identify as many studies in the field as possible. This allowed us to have a better overall scope of the approaches as the varied terminology is often used to express the same phenomenon. For all of the key literature, the main entry points were IEEE Xplore bibliographic database, ACM Digital Library as well as Google scholar. A total of 82 papers from 1994 to 2014 were included in the final analysis for the quality approaches in the field of Technology Enhanced Learning. Most papers focus on the recent 5 years of research. Currently the oldest learning object repositories are starting to be about 17 years old (Zervas et al., 2014), which makes this the correct period to analyze also the studies on them.

The synthesis part of the literature review takes a constructive approach (Crnkovic, 2010). Constructive research is suitable for construction of a solution (artifact or a theory) that is based on existing knowledge (Crnkovic, 2010). In our case the approach is to build on existing knowledge on quality approaches and to construct an artifact in form of a framework in order to study the quality approaches for LORs. Therefore, the conceptual framework is aimed towards theory building (Nunamaker, Chen, & Purdin, 1990) by contributing to the body of knowledge with a variety of challenges that require validation in real stakeholder contexts.

The constructive part is combined with the approach of Kitchenham (2004) by analyzing, synthesizing and interpreting the literature in order to finalize the data analysis and construct the quality assurance framework.

5. Quality approaches – a critical analysis of current literature

This section describes how quality approaches have been studied in Technology enhanced learning field. As the main result, our study synthesizes the findings by introducing the Learning object repositories quality assurance framework (LORQAF). To better explain the quality assurance process and actors, we synthesized the data in order to classify the identified quality approaches in the Learning object repositories quality assurance framework LORQAF. This framework will serve as a holistic approach for understanding the overall picture of LORS quality approaches. LORQAF is presented in Fig. 1.

During the data extraction phase (Kitchenham, 2004), we found out that quality assurance strategies often are a combination of many choices made by the LOR developer: Which standards to use, which evaluation criteria to select, which tools to give out to the community. For the sake of discussing the variety of quality approaches we will harmonize the approaches to categories according to the quality assurance classification of Table 1. For example a technology developer can set automated recommender systems to give out featured resources to the users, but the recommendation algorithms are often based on users' actions in the repository portal, which means that the only through a powerful community can the recommender system approach succeed. Many quality approaches are operationalized before publishing the educational resources, however, quality assurance is an ongoing process and most repositories offer both technological as well as user-generated collaborative quality instruments. In the current LOR trend, repositories are moving from pre-publication reviews towards post-publication reviews based on a open community reviewers (Atkins, Brown, & Hammond, 2007).

The following tables present the dimensions of the framework. The selected characteristics include:

- Policy – usually set as an overall approach for the repository by the technology developer.
- Technological – Automated technology & services provided within the portal.
- Social – Many quality approaches demand collaborative actions from the community making them quality co-creators.

The following Tables 2–4 describe quality approaches their characteristic and the key references.

Many comprehensive reviews of quality approaches (such as Atenas & Havemann, 2014 and Palavitsinis et al., 2013) on LOR quality only include quality instruments, which means that the

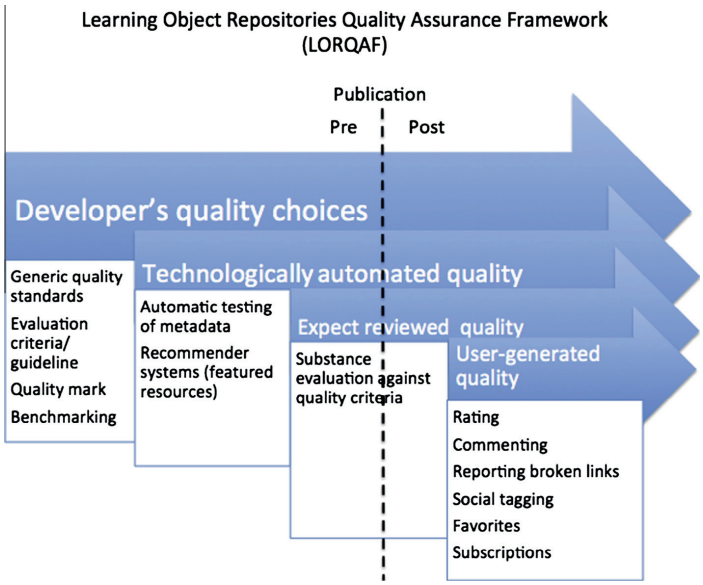

Fig. 1. Learning object repositories quality assurance framework (LORQAF).

Table 2
Generic quality approaches.

LORQAF – Generic quality approaches		
Quality approaches	Characteristics	References
Use of quality standards such as ISO 9000	Policy	Manouselis et al. (2010), Stracke and Hildebrandt (2007), Clements and Pawlowski (2012), Ehlers and Pawlowski (2006a,b), Hirata, 2006, Saarti, Juntunen, & Taskinen, 2010, Zschoke and Beniest (2011), Stracke (2009), Ehlers, Goertz, Hildebrandt, and Pawlowski (2006)
Use of Standardized metadata	Technological	Atenas and Havemann (2014), Barker and Ryan (2003), Currier (2004); Smith and Casserly (2006), Wiley (2007), Wilson (2008, 2007), Palavitsinis et al. (2013), Barton et al. (2003), Howarth (2003), Moen, Stewart, and McClure (1997), Park (2006)

generic approaches and the policy level of the repositories is considerably less researched than specific approaches and instruments. This might also be due to the complexity of standards like ISO 9000 (ISO 9000, 2014). 24 papers from the years of 1998 to 2014 were identified to present generic quality approaches such as quality standards or using standardized metadata as the quality approach.

20 papers from 1994 to 2012 were identified to tackle the issue or specific quality approaches. Quality benchmarking seems to have been in fashion around 10 years ago, but the current approaches in quality assurance are moving towards specific quality instruments rather than checking the quality of the materials against criteria by experts. However, the lack of a powerful community to back up the collaborative instruments (Zervas et al., 2014), expert review would be a vital part in assuring the quality of the resources.

Total of 56 papers were identified to propose specific quality instruments for quality assurance of LORs. The timeline of these studies were published in between 1995 and 2014. Most specific quality instruments have two dimensions: The technological and the social, collaborative characteristic. This means that the LOR developers code technological quality assurance features into the portal interface and then expect the users' to interact with the feature to provide evidence of quality for others in the same community. During this literature review, we identified the total of 15 different quality assurance approaches by specific quality instruments.

6. Discussion

Social interaction is considered to be the dominant factor affecting collaboration in groups (Kreijns, Kirschner, Jochems, & Van Buuren, 2007). Specific quality instruments such as studied in this paper can increase social interaction and collaboration between users. In fact, the most cited quality approaches from the TEL literature seem to have been specific quality instruments: 'peer reviewing' and 'recommendation systems'. This clearly indicates that the future trend of repositories is not only moving towards facilitating collaborative interaction between users as Chatti, Jarke, & Frosch-Wilke, 2007 predicted but is doing so through quality assurance related specific instruments. Unfortunately, the mere existence of these features does not guarantee the repository to be successful. Ratings are an easy feature for repository developers to add, but this study does not go deeper into how much the users are actually rating content or commenting on them. These kinds of features work in the field of e-commerce where strong communities in web shops like eBay can show user ratings from masses and that actually contributes towards the user's perception of the quality of the object. However, in the field of education, users have different level of motivation in using quality assurance features and such repositories in general. Collaborative instruments alone cannot

Table 3
TEL Specific quality approaches.

LORQAF – TEL specific quality approaches		
Quality approaches	Characteristics	References
Expert review	Policy	Atkins et al. (2007), Catteau, Vidal, and Broisin (2008), Kurilovas (2009); Sanz-Rodríquez Dodero, and Sánchez-Alonso (2010), Kumar, Nesbit, and Han (2005), Westbrook, Johnson, Carter, and Lockwood (2012), Nielsen (1994), Clements and Pawlowski (2012)
Quality benchmarking	Policy	Atkins et al. (2007), Balagué and Saarti (2009), Wilson and Town (2006)
Quality guideline or criteria	Policy	Leacock and Nesbit (2007), Babalhavaeji, Isfandyari-Moghaddam, Aqili, and Shakooii (2010), Sinclair, Joy, Yau, and Hagan (2013), Vargo et al. (2003), Defude and Farhat (2005), Boskic (2003), Kurilovas (2009), Westbrook et al. (2012), Dobratz, Schoger, and Strathmann (2007)

Table 4
Specific quality instruments.

LORQAF – Specific Quality instruments		
Quality approaches	Characteristics	References
Peer review/user ratings (usually on likert scale 1–5)	Technological, Social	Atenas and Havemann (2014), Larsen and Vincent-Lancrin (2005), Schuwer (2010), Windle (2010), Minguillón, Rodríguez, and Conesa (2010), Stacey (2007), Lefoe, Philip, O'Reilly, and Parrish (2009), Catteau et al. (2008), Li (2010), Krauss and Ally (2005), Sanz-Rodríquez et al. (2010), Sampson and Zervas (2013), Currier et al. (2004) Zervas et al. (2014), Liddy et al. (2002), Waaijers and van der Graaf (2011), Venturi and Bessis (2006), Zhang, Jeng, and Li (2004)
User evaluation tools (e.g. LORI)	Technological, Social	Atenas and Havemann (2014), Clements and Pawlowski (2012), Downes (2007), Richter and Ehlers (2010); Atkins et al. (2007), Sinclair et al. (2013), Vargo et al. (2003), Defude and Farhat (2005), Kumar et al. (2005), Alharbi, Henskens, and Hannaford (2011)
Recommender systems (featured resources)	Technological, Social	Manouselis et al. (2013), Atenas and Havemann (2014), Pegler (2012), Petrides et al. (2008), Adomavicius and Tuzhilin (2005), Duffin and Muramatsu (2008), Manouselis and Sampson (2004), Manouselis, Drachsler, Vuorikari, Hummel, and Koper (2011), Li (2010), Sanz-Rodríquez et al. (2010), Sabitha, Mehrotra, and Bansal (2012), Sampson and Zervas (2013), Zervas et al. (2014)
Commenting	Technological, Social	Minguillón et al. (2010), Catteau et al. (2008), Li (2010), Vargo et al. (2003), Sanz-Rodríquez et al. (2010), Sampson and Zervas (2013), Waaijers and van der Graaf (2011)
Favorites	Technological, Social	Minguillón et al. (2010), Sanz-Rodríquez et al. (2010), Sampson and Zervas (2013), Zervas et al. (2014)
Social tagging	Technological, Social	Minguillón et al. (2010), Stacey (2007), Sampson and Zervas (2013)
Subscription (e.g. RSS-feed)	Technological	Minguillón et al. (2010), Sampson and Zervas (2013), Zervas et al. (2014)
Flagging (reporting on broken links, inapproperiate content etc.)	Technological, Social	Sinclair et al. (2013), Clements and Pawlowski (2012)
Keywords of the resources	Technological	Atenas and Havemann (2014), Davis et al. (2010), Richter and McPherson (2012)
Multilingualism of the repositories	Technological	Atenas and Havemann (2014), OECD (2007), Pawlowski and Hoel (2012), UNESCO (2012)
Inclusion of collaborative social Media tools	Technological, Social	Atenas and Havemann (2014), UNESCO (2012), Minguillón et al. (2010), Sampson and Zervas (2013), Ehlers (2004)
Specification of the Authorship and IPR (e.g. creative commons licence	Policy	Atenas and Havemann (2014), Bissell (2009), Wiley, Bliss, and McEwen (2014), Wiley and Gurrell (2009), Attwell (2005), Browne (2010), Kanwar, Uvalić-Trumbić, and Butcher (2011), Petrides et al. (2008)
Availability of the source code or original files	Technological	Atenas and Havemann (2014), Atkins et al. (2007), Petrides et al. (2008), Tuomi (2006), UNESCO (2011), Currier et al. (2004), Ehlers (2004)
Trusted networks	Policy	Davis et al. (2010), Pawlowski and Clements (2013)
Automatic testing of metadata	Technological	Defude and Farhat (2005), Palavitsinis et al. (2013), Kurilovas (2009), Liddy et al. (2002), Stvilia, Gasser, Twidale, Shreeves, and Cole (2004), Strong, Lee, and Wang (1997)

assure quality if there are no communities to back them up. As quantitative studies of LORs by Ochoa and Duval (2009) and Zervas et al. (2014) noticed, there are very little repositories with actual user community strong enough to be working like a wikipedia to assure their quality through collaboration.

Based on this literature review, it is our recommendation that the LOR and CSCL environment developers would take a mixed approach for assuring their quality. Expert review might be not the most economical approach, but it seems to be needed in order to evaluate the substance of the resources in the repository. Once the community is strong enough, the user-generated collaborative quality instruments such as peer reviews, comments and rankings can be trusted more to assure the quality of the LORs and CSCL environments. LOR and CSCL developers should think of the quality assurance as a holistic approach:

1. What are the quality policies of the repository or environment?
2. Which quality assurance instruments can be automated?
3. Quality assurance before or after the resource is published?
4. Ensuring quality by paying external experts to review resources?
5. Which user-generated collaborative quality instruments we want to include?
6. What will be the most cost-efficient and sustainable quality assurance approach in the future?

It is our expectation that the LORQAF can be a useful tool when choosing the quality assurance approach for a learning repository or updating a previous one.

7. Summary

As the main contribution of this study, we constructed an LOR quality assurance framework (LORQAF) for LOR developers to take

into consideration when building future repositories or updating the existing ones. Within the first part of the study, we analysed LOR quality literature within open and technology enhanced learning domains. Our analysis highlighted the state of the art and compiled a comprehensive overview of the most researched quality approaches, instruments and metrics. The framework is foreseen to be applied in qualitative studies that address LOR Quality approaches. It can also be utilized in quantitative approaches, such as incorporating it for studying LOR success eg. using the DeLone & McLean IS success model (DeLone & McLean, 1992, 2003). Our findings indicate that the future of LORs quality assurance relies heavily on collaborative instruments, which encourage users to participate in the co-creation of the CSCL environments.

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V

HOW DO WE MEASURE OER REPOSITORIES' SUCCESS? – A SYSTEMATIC LITERATURE REVIEW

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HOW DO WE MEASURE OPEN EDUCATIONAL RESOURCES REPOSITORIES SUCCESS? – A SYSTEMATIC LITERATURE REVIEW

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Abstract

Regardless of the amount of educational resources available, many Open Educational Resources Repositories (OERRs) are often seen as unsuccessful. In consequence, finding models for sustainable collections is a key issue in repository research. The main issue is to understand the evolution of successful repositories. Success of OERRs has been studied before but there has not been consensus in the community on how to measure the repositories success. Studies around the success of the repositories have also often focused entirely to the perspective of the OER developers, forgetting that the users might have a different idea of a successful repository. In this research, we conducted a comprehensive literature review tackling the issue of repository success in the field of technology-enhanced learning. Our findings show that various metrics have been proposed by previous literature for the OERR's success. Most repositories gather data on a collection of success indicators, which typically take into consideration 1) monthly or daily user rates/page views, 2) download counts or hits in the interface portal. However, these indicators might not be considering the life span and sustainability of the repository, nor do they track transcendent success. In this research, we conducted a systematic literature review on how to measure OERRs' success. The Main contribution of this study is a recommendation of OERR success metrics framework that can help developers, communities and future projects of OERRs in designing ways to measure success of their repository.

Keywords: Open Content, Open Educational Resources, Learning object repositories, Success, Metrics, Success indicators

1 INTRODUCTION

For the last two decades, a rapidly growing amount of Open Educational Resources (OER) have become available in OER repositories (OERRs) for educators to re-use, re-publish and share within their communities [1]. Previous studies have identified that repositories fail to create an active community around them [2][3][4]. How do we define a successful OERR? Most repositories gather data on success indicators, which typically take into consideration monthly daily user rates/page views, download counts or hits in the interface portal [2]. Various metrics the past have been proposed by previous literature for the Learning object repositories success (e.g. [5][6][7][8][9][10][2][11][12][13][14]. In these studies, specific metrics, tools and methods are discussed that allow repository managers to assess the success of the deployed repositories. Perhaps the most extensive quantitative study by Ochoa & Duval [2] analysed OERRs with metrics of "Content growth, Contribution growth, lifetime & publishing rate." The quantitative use analytics provide a restricted measurement of OERR's success. Information systems such as OERRs can also be evaluated through Delone & McLean IS Success model [15][16][17] in which information, system and service quality can lead to use & user satisfaction, and through that towards net benefits. As previous research has not been able to agree on a stable definition of OERR success, in this paper we will discuss OERR success based on the previous literature metrics.

The literature review followed the steps defined by Kitchenham [18] for conducting a systematic literature review analysis. Our research questions were: How to measure OERR success? Which

indicators and metrics are mentioned by previous studies? A total of 20 relevant papers from 2002 to 2014 were identified in the final analysis for the success metrics.

When the project ends and the support of the community building activities end - the repositories content & user base stop growing. However, the repository might have been successful from certain perspectives even if 'it dies'. In this paper we discuss the concept of OERR success from the perspectives of two key stakeholder groups: The users and the developers.

2 THEORETHICAL BACKGROUND

2.1 Open Educational resources

UNESCO defined Open Educational Resources (OER) as "technology-enabled, open provision of educational resources for consultation, use and adaptation by a community of users for non-commercial purposes" [19]. Downes [1] defined OER: "In the system implemented by Creative Commons (widely thought to be representative of an "open" license) authors may stipulate that use requires attribution, that it be non-commercial, or that the product be shared under the same license". So while "open" might mean "without cost," it doesn't follow that it also means "without conditions." Davis & al. [6] described educational resources as sets of resources, which have been assembled and described with the intention that they could be picked up and re-used by others. This study defines OER as "All resources for the purpose of learning, education and training which are accessible, modifiable and re-usable within the limit of an open license". This means that the OERRs business model does not include selling the materials themselves, but perhaps adverts, add-on services or other via other activities. OER can be literature and scientific resources (Open Access for Education), technologies and systems (Open Source for Education) and Open Content (actual learning materials / contents) as well as related artefacts (such as didactical materials or lesson plans).

2.2 Open educational resources repositories

Learning object repositories (LORs) ca be defined as digital databases that house learning content, applications and tools such as texts, papers, videos, audio recordings, multimedia applications and social networking tools **Error! Reference source not found.**. Open educational resources repositories (OERR) are LORs containing OER. OERR are multi-functional platforms which are designed to facilitate access to reusable learning objects in a variety of formats, so users can search for, find and make use of this content [21]. OERRs are databases full of OER, accessible for users via its interface portal. OERRs in the last five years can be typed based on the community developing the service. In this study we look into the following types of repositories (see Table 1: Typology of OERRs):

Table 1: Typology of OERRs

Type	Main characteristics	Examples
National repositories	Users all school teachers (& students of one country), often supported by the ministry of education of the country	Lefo (Estonian national repository) http://lefo.net/
Thematic repositories	Focuses in providing content around a certain topic like 'Science, Music or Art'	Discover the Cosmos (Astronomy content) http://portal.discoverthecosmos.eu/
Federated international repositories	Typically harvest metadata of other repositories and bring critical masses of OER available	Open Discovery Space http://opendiscoveryspace.eu

McGreal's [20] study has been widely used as it identified the principal functionalities of OERRs as: search/browse OER, view OER, download OER, store OER and download OERs metadata. Tzikopoulos et al., [22] studied the general characteristics of 59 well-known OERRs covering such issues as: subject areas, metadata standards, languages available, quality control, evaluation mechanisms and IPR. Ochoa and Duval [23] carried out a quantitative analysis of OERRs growth,

focusing on the numbers of learning objects and users' growth over time. According to their analysis, most OERRs grow linearly – however two years later the more detailed study of the Connexions (later known as "CNX") repository showed there to be at least one exception to the rule as it is clearly exponential growth [3]. A Recent study by Zervas et al., [24] analysed 49 OERRs for their functionalities highlighting the core functionalities, which match McGreal's [20] findings. The newest trends of OERRs have focused on providing community-fostering services such as social media features within the OERR interfaces [25]. OERR development has also started to move towards fostering more community than learning object creation. Critical masses of content were achieved by harvesting repositories into massive federated OERRs [26](, however, the users started now to be even more concerned about the quality of the OERRs and content inside[27].

2.3 OERR Success

The *Oxford English Dictionary* offers an etymology for "success" from the 16th century, simply as "the accomplishment of an aim or purpose." A judgment of "success" can be dependent on the perspective of whoever sets the aim, as well as who assesses whether the purpose was accomplished [28]. The concept of success is highly subjective and dynamic, the aims and goals can change over the period of observation. Definitions of success often vary by the perspective of the stakeholder or unit (user, developer, funder, surrounding organisation etc.)[29]. Myers [30] suggests that success is achieved when an information system is *perceived* to be successful by stakeholders. However, given this human tendency to underestimate challenges and to overestimate their own capabilities, stakeholders could perceive as a partial failure a project that was in fact successful in achieving near-optimal results [31]. Wilson & Howcroft [32] suggest that, success and failure in IS can be seen a social accomplishment dependent on the perspective of the subject.

Any information system (IS) such as a learning object repository has many stakeholders, each with a different definition of system success [33]. Developer's perspective might be that the system is built according to its specifications and functions correctly within the project's budget. User's perspective might be that it includes useful & easy-to-use information. Funder's perspective might be that system attracts a large growing community of users. It is no news that software projects often fail and learning object repositories are no different. Repositories certainly are not used up to their full potential [2][34][35].When discussing the success of an information system, it is relevant to look at the success of the software project that created the IS in question, but in this research we focus on the success of the systems, rather than the project, meaning that the aim of many learning object repositories is to continue their operations after the project that created it, is over. Therefore we need to analyse not just the success of the project, but the outcome, the system itself.

Successes of OERRs have been studied previously (e.g. [2][22][36][37]. Many previous studies have focussed on success factors or success criteria [38]. Monge et al., [25] recommended social repository characteristics leading to success: 1) Clear authorship and use license attribution, 2) Rapid content creation, 3) Indexable content for search engines, 4) Social tagging, 5) Reputation systems for contents and 6) Social recommendation systems. Change of working culture is a huge success factor of a OERR. This requires the alignment of techincal, communal and institutional goals and motivations [6]. According to Højsholt-Poulsen, & Lund [37], user-based repositories seem to have more success with involving teachers and creating an active community around their repository than is the case for most traditional top-down approaches. Yeomans [39] reminds us that even the most mature repositories, such as the physics community's *arXiv*, may generate impressive statistics, but offer little to help anyone know what kind of "success" those figures measure. Nor has there been a consensus in the community on which success metrics to use. Ochoa [3] identifies the 'Connexions' repository as an anomaly among unsuccessful repositories. Connexions had exponential contributors' and contents' growth, which was surprising, since most repositories grow linearly. Same forces that contribute to the success of Wikipedia and other wikis are also pushing the success of Connexions, and differentiating it from traditional OERRs. The key factors behind the success of Connexions [3]:

1) Increase the equity of the Connexions brand,
2) High quality, ample, modular, continually updated, personalized on assembly, published on demand content,
3) An engaged and involved user community and
4) Site usability.

Ochoa and Duval [2] quantitatively analysed the size, growth and contributor bases of LORs. Zervas et al. [24] also examined LOR success metrics such as the number of learning objects and users, as well as the age of the repository, revealing that the adoption level of the LO components' features and

added-value services can only marginally affect the LORs' growth. Petter et al. [40] suggested that measures might need to be different for systems, which have voluntary use, such as Learning Object Repositories. To measure the success of digital libraries, Khoo et al. [40] suggested the following metrics: Visits, Unique Visits, Page Views, and Hits. Vuorikari and Koper [13] suggested measuring different levels of re-use (the numbers of resources integrated into a new context).

3 METHODOLOGY

The literature review for the quality approaches was conducted using the systematic approach by Fink [42] as method to describe available knowledge for professional practice. The rigorous approach should be systematic with clear methodology, explicit in the procedures, comprehensive in the analysis and reproducible by others [42]. The literature review followed the steps defined by Kitchenham [18] for conducting a rigorous analysis. The steps include: (1) Identify need and define the method, (2) create research question(s), (3) conduct the search for relevant literature, (4) assess the quality and appropriateness of the studies, (5) extract data from the studies, (6) conduct data synthesis and finally (7) interpret the results and write a report.

This study looked at the technology enhanced learning literature between 2000-2014. 20 articles were identified to tackle the topic of OERRs' success measuring with quantitative methods. Main research on this topic has been published from 2008 onwards, however, Neven & Duval [10] looks at this topic much earlier, in the beginning of this century. These publications were peer reviewed journal or conference papers and therefore appropriate in their quality. The data was abstracted from the papers and synthesized into the OERR success-measuring framework.

4 FINDINGS

Success metrics of OERRs can be categorized into four types of measurements: 1) people, 2) resources and 3) interactions over the 4)OERR lifetime [9]. To emphasize the purpose of OERR to facilitate re-use of OER by uploading content as well as using it, this study categorized people into two types: Those who are 'users' and those who are 'contributors', to analyze the success of the repository on the level of which interactions take place. Figure 1 OERR Success components to measure show the typical OERR success metrics settings.

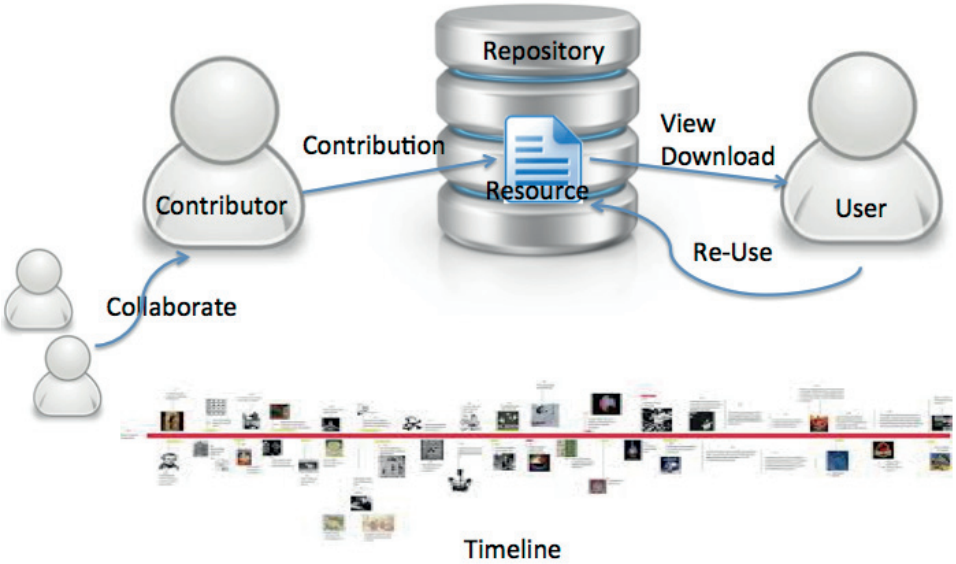

Figure 1 OERR Success components to measure

All the success metrics found from the previous literature have been summarized into Table 2. It is also a finding of this study that Interactions are typically analyzed over the periods of days, months or

years (Number, growth or frequency). Mere analysis of use (views/downloads), which is a common way of analyzing website activities, is not enough with an OERR, as the purpose of the repository is not only to gather users, but also to facilitate re-use of the resources. Participation by contributors is one of the most important indicators of a scholarly digital repository's success [31]. Users as co-designers of quality can lead to a successful repository that when coupled with a strong social framework enables a community to engage with high-level issues leading to changing practice [9], however user-generated quality interactions (such as described in 'Specific quality instruments' (ratings, peer review, commenting etc.) are not really considered as 'success measurements' by most authors of this topic. Millard et al. [9] suggests measuring users that comment on resources.

Table 2: Open Educational Resources repositories Success metrics framework

	Proposed measure(s) for success	**Proposed metrics**	**References**
Content related indicators	Size (LOs)	Number of uploaded or harvested LOs	Alharbi et al., 2011; Davis et al., 2010; Leinonen et al., 2010; McDowell, 2007; Millard et al., 2013; Neven & Duval., 2002;; Ochoa, 2010; Ochoa & Duval, 2009; Petrides et al., 2008; Thomas & McDonald., 2007; Vuorikari & Koper, 2009; Zervas et al., 2014
	Daily Growth	AGR =Average growth rate per day	Alharbi et al., 2011; Leinonen et al., 2010; McDowell, 2007; Millard et al., 2013; Ochoa, 2011; Ochoa & Duval, 2009; Ochoa, 2010; Petrides et al., 2008; Sánchez-Alonso et al., 2007; Sinclair et al., 2013; Zervas et al., 2014
	Yearly growth	LOs per year	McDowell, 2007; Millard et al., 2013; Ochoa, 2011; Petrides et al., 2008; Zervas et al., 2014
Contributor related indicators	Contributors	Number of contributors	Millard et al., 2013; Ochoa, 2011; Ochoa & Duval, 2009; Ochoa, 2010; Thomas & McDonald, 2007; Petrides et al., 2008; Sánchez-Alonso et al., 2007; Thomas & McDonald., 2007
	Specific contributors	Contributor distribution per categories; active contributors	Thomas & McDonald., 2007
	Contributor growth	Average number of contributors on a certain period of time	Ochoa & Duval, 2009; Ochoa, 2010; Sánchez-Alonso et al., 2007;
	Publishing rate	Number of LOs per contributor/time period	Millard et al., 2013; Ochoa, 2011; Ochoa & Duval, 2009; Ochoa, 2010; Petrides et al., 2008; Sánchez-Alonso et al., 2007; Thomas & McDonald., 2007
	Contributon frequency	How often contributor contributes?	Ochoa, 2011; Ochoa & Duval, 2009; Ochoa, 2010; Sánchez-Alonso et al., 2007
	Contributor lifetime	Time period on when contributions actively happen	Ochoa & Duval, 2009; Ochoa, 2010; Sánchez-Alonso et al., 2007
	Collaborative editing	More than one contributor per LO.	Leinonen et al., 2010; Ochoa, 2010; Petrides et al., 2008
User related	Users	Number of users	Leinonen et al., 2010; Millard et al., 2013; Vuorikari & Koper, 2009; Zervas et al., 2014
		Users per year	Millard et al., 2013; Zervas et al., 2014
		Returning users	Højsholt-Poulsen, L., & Lund, T., 2008; Zervas et al., 2014

		Commenting users	Millard et al., 2013
	Use	Downloads	Bond et al., 2008; Davis et al., 2010; Millard et al., 2013; Ochoa, 2011; Ochoa & Duval, 2009; Rosell-Aguilar, F., 2013; Sinclair et al., 2013; Vuorikari & Koper, 2009;
		Views (of metadata)/Popularity	Davis et al., 2010; Khoo et al., 2008; Millard et al., 2013; Ochoa, 2011; Ochoa, 2010;
	Re-use	Re-published	Ochoa, 2011; Ochoa, 2010; Vuorikari & Koper, 2009
		2nd or nth level reuse	Vuorikari & Koper, 2009
Repository related	Lifetime	Age of the repository	Khoo et al., 2008; Ochoa, 2011; Ochoa & Duval, 2009; Thomas & McDonald, 2007; McDowell, 2007; Millard et al., 2013;

This framework extended the previous studies of Ochoa & Duval [2] and Millard et al., [9].

5 DISCUSSION

We reviewed OERR success metrics throughout the technology enhanced learning literature. Our findings show that the typical metrics take into consideration along the lines of (adapted from [9][12]):

1. People - Contributors & Users(Number of, growth, number of active, contribution frequency, contribution lifetime, collaborative edit)
2. Resources (Size, growth)
3. Interactions (Visits, Views, Dowloads, Re-use, Contribution, Commenting, Collaborative contribution)
4. Repository lifetime

Most repositories measure success with contents' and users' growth, which alone do not describe the full picture of the interactions that take place in these repositories. Even those repositories, which measure the interactions, cannot necessarily describe transcendent success. This means benefits or outcomes, which OERR developers see as "successful," such as content, technology or developers' competences enduring after the repository itself has ceased operation. Previous studies [47] have also shown that success does not necessarily mean user engagement but that repository developers might see OERR successful if it has functioned as a test bed for them. Metrics such as these are often set by the OERR developers and only show a limited picture of the OERR success.

When a teacher goes to a portal to look for resources for their lesson, that teacher might find a resource that was fitting perfectly to his/her lesson and therefore the teacher might perceive that repository to be a success. Even if that teacher would use and re-use that resource throughout his/her 30 year career as a teacher, it might be that the teacher would never return to the repository; would never upload a new version of the resource to the repository. This would mean that the success metrics would not detect the perceived success from the point of view of this user. Another example would be that the repository itself stops growing, but the contents of it are harvested into another repository and therefore have a lot longer lifetime than the success indicators would allow us to believe, as was the case of many repositories within the umbrella portal of Open Discovery Space [48]. The age of a repository, and the age of items it contains, can significantly confuse any analysis and comparisons of scholarly repositories [12]. This is particularly true for repositories, which have not yet run out of their 'initial funding' and have not found sustainable business models [1]. Quantitative metrics alone cannot judge the success of a repository, but they can give an indication of whether the interactions which the developers intended to happen between users, contributors and content actually take place. It is our recommendation that quantitative success metrics would be used along with qualitative interviews of all relevant stakeholder groups with a longitudinal study to determine the success of OERRs.

CONCLUSION AND FUTURE RESEARCH

Purpose of this study was to identify metrics in which OERRs measure their success in previous studies. A systematic literature review showed that most OERRs measure their success by indicators of users, contributors, resources, interactions and lifetime. The main contribution of this study is the OERR Success Metrics Framework based on the findings of the literature review. This contribution extends the work of Ochoa and Duval [2] and Millard et al., [[9], who studied OERRs' content and contributor base growth over time. This research can be used by OERR developers and repository owners to design ways to measure the success of their repository can use this success metrics framework. This framework could also be used by researchers to measure OERR success, specifically in longitudinal studies. Limitation of this research is that by measuring OERR success with quantitative measures only, the analysis of success might not cover transcendent benefits such as the use of the repository as a test bed. Therefore it is the recommendation of this study to use qualitative analyse to complement quantitative measuring of OERR quality, specifically to determine whether stakeholders' expectations for a successful repository were met.

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VI

WHY OPEN EDUCATIONAL RESOURCES REPOSITORIES FAIL – REVIEW OF QUALITY ASSURANCE APPROACHES

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WHY OPEN EDUCATIONAL RESOURCES REPOSITORIES FAIL – REVIEW OF QUALITY ASSURANCE APPROACHES

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Abstract

Regardless of the amount of open educational resources (OER) available, many learning object repositories LORs fail to attract active users and sustainable funding solutions. Previous studies indicate that quality of OER plays a significant role in the success of the repositories; however, there is a lack of systematic deeper understanding of this connection. In this qualitative study we interviewed 35 managers/developers of 27 national, thematic and federated LORs in regards of the LORs' quality approaches and success. The key findings of this study show that comprehensive quality approach leads to success of the repository in most cases, the key instruments for quality assurance being expert and peer reviews. Contribution of this research is the review of LOR quality approaches. This study helps LOR developers to design sustainable quality assurance approaches.

Keywords: Open Content, Open Educational Resources, Learning object repositories, Quality assurance, Success

1 INTRODUCTION

In the last ten years, the number of open content or more generally Open Educational Resources (OER) as well as their availability and distribution via OER repositories (LORs) has rapidly increased. There clearly has been a general awakening in the e-Learning community regarding OER [1]. More LORs are built and metadata of existing repositories are harvested by federated repositories [2] to improve access to high numbers of OER. This process brings critical masses of OER available to users, at the same time raising an increasing need for quality control of resources [3]. Regardless of the amount of educational resources available, many LORs are not used to their full potential [4]. According to [2], not enough studies have been done to obtain an accurate idea of the nature and status of development of LORs, which motivated our study. Quality of OER plays a significant role in the success of the open content repositories (LOR) [5];[6]) therefore it's vital to study the quality approaches effects on the repositories' success.

Learning object repositories use three levels of quality approaches [7]: 1. The Generic Approach of Quality standards (e.g. ISO 9000 standards [8], European Foundation for Quality Management Excellence Model [9], 2. Specific Quality Approaches (e.g. Content development criteria or competency requirements)[9] and 3. Specific Quality Instruments (e.g. user generated quality approaches such as rating[11], peer review [12] or recommender systems [13]. In this study we investigated the use of different levels of quality approaches in LORs. Previous LORs reviews have often been on a general level, listing the features of repositories [12]or their characteristics [2]. OCRSs have also been quantitatively analyzed regarding their size, content growth and distribution [4]. Recent study by Atenas & Havemann [14] reviewed the OER Repositories technical and social quality approaches on a numerical level. However, the quality approaches have not been evaluated in a holistic level, which would also aim at understanding how quality approaches can affect the success of the repository. This study covers that research gap. The contribution of this research is a review and analysis of 27 LORs' quality approaches and their effects on the repositories' success and can give a recommendation on future developers of LORs regarding their quality assurance strategy.

2 OPEN EDUCATIONAL RESOURCES

Open Educational Resources are often not clearly defined. UNESCO defined OER as "technology-enabled, open provision of educational resources for consultation, use and adaptation by a community of users for non-commercial purposes". [15] This is contrasted by the current use of equivalent approaches such as Open Source [16] or Open Access ([17];[18]). Downes [1] described OER: "In the

system implemented by Creative Commons (widely thought to be representative of an "open" license) authors may stipulate that use requires attribution, that it be non-commercial, or that the product be shared under the same license. So while "open" may on the one hand may mean "without cost," it doesn't follow that it also means "without conditions." Davis & al. [19] described educational resources as sets of resources, which have been assembled and described with the intention that they could be picked up and re-used by others. This study defines OER as "All resources for the purpose of learning, education and training which are freely accessible for the user". This means that the LORs business model does not include selling the materials themselves, but perhaps adverts, add-on services or other via other activities. OER can be literature and scientific resources (Open Access for Education), technologies and systems (Open Source for Education) and Open Content (actual learning materials / contents) as well as related artefacts (such as didactical materials or lesson plans).

2.1 Distribution and re-use: Learning object repositories (LOR)

The Internet has enabled OER to be available in large masses all around the world. To answer the question of "How the right OER might find users and how the OER might be re-used in various communities", LOR repositories were established. LOR are multi-functional platforms which are designed to facilitate access to reusable learning objects in a variety of formats, so users can search for, find and make use of this content ([20];[21]). LORs are databases full of OER, accessible for users via its interface portal. LORs in the last five years can be typed based on the community developing the service. In this study we look into the following types of repositories (see table 1):

Table 1: Typology of learning object repositories.

Type	Main characteristics	Examples
National repositories	Users are school teachers (& students of one country), often supported by the ministry of education of the country	Miksike's Lefo (Estonian national repository) http://lefo.net/
Thematic repositories	Focuses in providing content around a certain topic like 'Science, Music or Art'	Discover the Cosmos (Astronomy content) http://portal.discoverthecosmos.eu/
Federated international repositories	Typically harvest metadata of other repositories and bring critical masses of OER available	Open Discovery Space http://opendiscoveryspace.eu

Various studies on Learning object repositories have been conducted in the recent past, Tzikopoulos & al. [2] made a comprehensive investigation on LORs' characteristics. [4] analyzed quantitatively the size, growth and contributor bases of LORs. [12] compared features of LOM repositories. Several European Commission funded projects have also researched the success of LORs, most recently EdReNe network in their report "Building successful educational repositories" [22]. Many have focused in recommending how repositories should be built ([23]; [24]). Many have focused on the lifecycle or evaluation of the repositories ([25]; [26]).

2.2 Success of LORs

In previous studies, we have identified that repositories fail to create an active community around them [4]. How do we define a successful LOR? Most repositories gather data on success indicators, which typically take into consideration monthly daily user rates/page views, download counts or hits in the interface portal [22]. Various metrics the past have been proposed by previous literature for the Learning object repositories' ([27]; [28];[29]) success. In these studies, specific metrics, tools and methods are discussed that allow repository managers to assess the success of the deployed repositories. Perhaps the most extensive quantitative study by Ochoa & Duval [4] analysed LORs with metrics of "Content growth, Contribution growth, lifetime & publishing rate." The quantitative use analytics provide a restricted measurement of LOR's success. Information systems such as LORs can also be evaluated through Delone & McLean IS Success model [30][31] in which information, system and service quality can lead to use & user satisfaction, and through that towards net benefits. As previous research has not been able to agree on a stable definition of LOR success, in this paper we will define LOR success based on the previous literature metrics (Content growth, Contribution growth,

lifetime & publishing rate) enhanced with our findings - from the perspective of LOR developers – what is LOR success for the developers.

3 QUALITY ASSURANCE OF OER

Quality can mean different things to different people in different contexts. In this way, if we want to really understand quality, we cannot study it in a vacuum but rather as a part of a given community of practice and a specific product [3]. Quality can be defined as "[…] *appropriately meeting the stakeholders' objectives and needs which is the result of a transparent, participatory negotiation process within an organization*." [32]. In the context of OER and LORs quality can mean that teacher finds a suitable resource for his/her teaching. Previous studies on LOR have highlighted the issue of quality assurance of repositories, as this is seen as key to provision of quality content to end users ([12];[33]).

Learning object repositories quality approaches vary on the level [14] of stakeholder involvement: Certain approaches are relying heavily on user generated quality, whereas other approaches are so-called 'Top-Down' solutions where the quality has been evaluated by an outside expect according to the quality criteria or framework of the LOR. In general, three levels of LOR quality approaches can be distinguished:

Table 2: Quality approaches (Enhanced from [7])

Approach	Purpose	Examples
Generic quality approaches	Quality standards present concepts for quality management, independent of the domain of usage	• ISO 9000:2000 [8] • EFQM [9]
Specific Quality approaches for TEL domain	Quality management or quality assurance concepts for the field of learning, education, and training, top-down approach	• QAA Framework Consortium for Excellence in Higher Education [34]. • Quality criteria, [35]
Specific quality instruments	User generated quality mechanisms for managing specific aspects of quality, bottom-up approach	• Ratings [11] • Recommender Systems [13];[6];[36] • Peer reviews [12] • Trusted networks approach [37]

Generic approaches (Quality standards) contain domain-independent quality approaches and can generally lead to trust in certified organizations. Those provide a consistent minimum quality of OER and technologies. If an organization uses for example the EFQM excellence model [38], it is assured that all products have been assessed and quality controlled. While the EFQM-Model is used for self-assessment, the ISO 9000 is used to prove organizations by external assessment to earn a seal of approval [39]. In the context of this study, we investigate the use of quality standards as a basis for the repository's quality approach.

Specific approaches differ in scope and methodology, ranging from quality marks for education [40] to content development criteria [9] or competency requirements [41]. They aim at achieving high quality of OER and related technologies. Specific quality approach is appointed by the LOR developer, but often approved by a community/counsel of experts reviewing the approach. In our study, we investigated four different types of specific quality approaches (Adopted from [7]):

1. Expert review (ER) – All OER in the LOR is checked by a thematic expert of the field
2. Quality Criteria (QC) – LOR has set itself quality metrics (which the OER is checked against)
3. Quality Mark (QM) – LOR adds a quality badge which allows users to recognize high quality OER
4. Quality framework(QF) – LOR sets OER quality by an existing, recognized quality framework

Specific instruments can be defined as user-generated quality. LOR developers set technical features to the repository which allows the community to contribute to the quality either directly (rating, reviewing, commenting, flagging etc.) or indirectly (The LOR portal can monitor the users' activities and based on that social data, make automatic promotions of content (recommendation systems) As OER repositories need sustainable solutions for quality assurance, specific quality instruments have become increasingly popular. Unfortunately, in voluntary settings in OER communities, it is not easy to

find adequate motivated reviewers; so specific quality instruments can only work with a strong community behind them **Error! Reference source not found.**. LOR developers favor specific quality instruments because they are cost effective, however, they are problematic also because of the context nature of quality. In our analysis, we checked eight different types of specific quality instruments (Adopted from [7]):

1. User ratings (UR) – Users can give "stars" or "likes" to the OER
2. Peer reviews (PR) – Users can write longer reviews of the OER
3. Recommender systems (RS) – LOR recommends OERs to the users based on their previous activities in the LOR portal
4. Commenting (CO) – Users can comment on OER
5. Flagging/Disclaimer (FL) – Users can report bad content (e.g. broken links)
6. Sharing (SH) – Users can share OER inside the LOR/in social media with their friends and colleagues
7. Automatic metadata testing (AM) – LOR checks the lacking fields of metadata automatically
8. Trusted networks approach (TN) – LOR trusts the organizations or individuals creating the OER without checking the content (specially popular approach among federated repositories as they have too much content for reviewers to check)

4 METHODOLOGY & ANALYSIS CRITERIA

In this study, we interviewed 35 managers/developers (27 Europeans, 1 Northern American, 7 Latin Americans) representing 27 repositories. In some cases more than one persons were interviewed for one repository in order to catch both the perspective of managers as well as a person in charge of the user community building (sometimes these roles were taken by the same person and sometimes they were conducted by two or more persons). The repositories were selected based on a large variation sampling; we wanted to include both successful and less successful repositories, as well as representatives from each three types of repositories (National, thematic, federated – international) as well as different sizes of repositories. Our sampling method aimed to show country groups and context which are essential to fulfill the UNESCO goals of global collaboration [43]. The contribution of this research is a review and analysis of 27 LORs' quality approaches and their effects on the repositories' success. This research can benefit developers and managers of LORs regarding the choices towards their quality assurance approaches. In the case of Latin America, interviewed experts were asked to introduce the researchers to other colleagues in the field. This can be seen as a snow-ball technique for sampling [44].

Qualitative multiple case study [45] methodology was chosen because of the need for deep understanding for the various cases. All interviews were conducted, transcribed, coded and analyzed by two researchers to avoid subjective bias. The interviews were conducted online (70%) (via Skype, Flashmeeting) or face-to-face (30%) depending on the availability of persons. The duration of the interviews ranged from half an hour to one hour. The analysis of the interviews was done following [46] guidelines for coding. Additional information was retrieved after the initial interview round from 60% of the interviewees. Additional materials were also obtained on case-by-case basis from the repositories' websites. In order to simplify the two approaches of quality approaches and success, we developed a comparable metric criterion for this paper based on previous metrics as well as the repositories' reporting of the ways they measure quality and success. This part of the analysis can be described as data-driven. Qualitative data can be presented in a numerical format for clarification, for this the examples of presenting evidence by [47] were followed.

Success analysis level criteria (simplified from [4] and [22]):

1. Contribution growth & publishing rate: Active users after the original funding has ended (1 point = 500-1000 users per month; 2 = several thousands per month; 3 = tens of thousands per month)

2. Lifetime: Funding sustainability point for Repository has been successful at receiving funding after the initial project/initiative has ended/Has sustainable funding otherwise, like under a ministry or company (1)

3. Content life cycle: LOR resources are being harvested by other initiatives (1)

This metric allows us to judge the repositories into levels of success: 1 = Failed; 2 = Marginally successful; 3 = Steady use but not growing; 4 = Quite successful; 5 = Truly successful with a steady user base and contributions.

Quality analysis level criteria (Elaborated from [48] and [7]): 1-3 points = 1 point for each level of quality approaches (Generic, Specific, Instruments); 1 point = Expert review (usually needs most funding); 1 point: 50% or more of different types of approaches used.

5 RESULTS AND DISCUSSION

Table 3 presents the full summary of this analysis for all 27 repositories. Repository acronym has been selected to present the continental background as well as type of the repository. Scales in the middle of the table show the levels of Quality approach review (Q) and Success review (S).

Table 3: Cross review of Success and Quality approaches in LORs.

Repository acronymn	Quality approach review	Q	S	Success review:	Scale
Europe.Federation1	**Instruments:** UR, CO, SH, AM, TN	1	3	University teachers still uploading content and students are consuming the content after 5 years since funding has ended	*~1000000 ERs*
Europe.Federation2	**Generic:** Quality standards **Specific:** ER, QC, QM, QF **Instruments:** UR, PR, RS, CO, FL, SH, TN	5	4	Still more than 1000 users per month, original project ended Summer 2011	~1200 ERs
Europe.Federation3	**Specific:** QF **Instruments:** UR, PR, RS, CO, FL, SH, TN	3	3	Ended 2012, Still occasionally used from outside the original consortium; Contents harvested to on-going projects	~15000ERs
Europe.Federation4	**Specific:** QC, QM, QF **Instruments:** UR, PR, RS, CO, FL, SH, AM, TN	3	4	On-going projects support, still used	*~1000000 ERs*
Europe.National1	**Specific:** ER **Instrument:** PR, CO	2	1	Still harvested to other repositories, no users of its own	~1600ERs
Europe.National2	**Specific:** ER **Instrument:** PR, CO	2	1	Still harvested to other repositories, no users of its own	~5000 video resources
Europe.Thematic1	**Generic:** Quality standards **Specific:** ER, QC, QM, QF **Instruments:** UR, PR, CO, FL, TN	5	4	Initial project followed by a second funding, which has ended in 2013, still active users, harvested to other portals	~100 000 ERs
Europe.Thematic2	**Specific:** QC **Instruments:** UR, PR, CO	2	2	Funding ended in 2010, Harvested by other portals, minor user activity on-going	~3500ERs
Europe.National3	**Specific:** Expert review **Instruments:** FL	3	2	Funding has ended 2010, few active users, objects are harvested into other repositories	~86000ERs
Europe.Commercial1	**Generic:** Quality standards **Specific:** ER, QC, QM, QF **Instruments:** UR, PR, CO	4	4	Runs through company funding, has users	1500 ERs
Europe.Thematic3	**Specific:** ER **Instruments:** UR, PR, CO	3	2	Funding has ended 2010, few active users, objects are harvested into other repositories	~800ERs
Europe.National4	**Instruments:** PR, TN	1	5	Run by the ministry of the country, 10 000 visitors per day	~50 000 ERs
Europe.National5	**Specific:** ER, QC	2	1	Harvested by other repositories	~3500ERs
Europe.National6	-	0	1	Resources are not available	~180

				except through other portals	courses
Europe.National7	**Specific:** ER, **Instruments:** FL, TN	3	4	Is providing a service through LMS, which has an active user base.	~2700ERs
Europe.National8	**Specific:** ER, QC **Instruments:** AM	3	3	Funded by the ministry, active daily use	~1000
Europe.National9	**Instruments:** PR, FL	3	3	Funded by the ministry, active daily use	N/A
Europe.National10	**Specific:** ER, QC **Instruments:** PR, SH	3	4	Funded by the ministry, active users	~100 000ERs
Europe.Thematic4	-	0	1	Not actively used on its own, but harvested to other collections	~300ERs
US.Federation1	**Specific:** ER, QC, QM, QF **Instruments:** UR, RS, CO, FL, SH, AM, TN	4	5	Run by a non-profit organization for over 7 years,	~70 000 ERs
Latinam.national1	**Specific:** ER, QC **Instruments:** UR, PR, CO, TN	4	4	Active users, run by the ministry	N/A
Latinam.federation1	**Instruments:** UR, RS, AM, TN	1	2	Has minor use	N/A
Latinam.thematic1	**Specific:** ER, QC **Instruments:** RS, TN	3	2	Has minor use	180 ERs
Latinam.thematic2	**Specific:** ER,QC **Instruments:** PR, FL	4	3	Fairly new repository, has active user base	32 courses
Latinam.federation2	**Instruments:** UR, CO, FL, SH	1	1	Owned by a university, experimental stage	N/A
Latinam.national2	**Specific:** ER, QC, **Instruments:** UR, PR, CO, FL, SH, TN	4	5	55-60 000 visits per day, supported by the ministry	N/A
Latinam.thematic3	**Instruments:** UR, RS, TN	1	1	SME run, very small amount of users	13000ERs

5.1 Quality approaches & success review cross analysis

We can see a pattern when comparing the two measurements for quality approach and success. In most cases the difference is (+1, -1 or 0). This study indicates that **quality approaches can be seen as a critical success factors for most LORs**. On average, the repositories analysed got 2,6 on their quality approaches and 2,8 on their success, which actually means just a 0,2 difference which points to the quality approach being highly indicating the success of the repository. Of course as previous studies [49] have shown, there are various barriers for LOR use, one must take into consideration that the quality assurance approach is just one aspect of the full success story. However, maximising the variation of quality approaches alone cannot make LORs successful, the combination of quality contributions from both developers (specific level) and users (instrument level) has the most cost-effective, sustainable solution.

Based on our analysis, three repositories reached the five points, indicating that these three repositories are successful: Europe.National4; US.Federation1; and Latinam.National2. Both the two latter repositories relied heavily on expert review, on their quality approaches, but also had put in place community-driven quality instruments such as peer reviews, ratings and flagging. It seems, as **quality assurance needs a mixed-approach with at least both the levels of expert review (Specific level) and user-generated (Instrumental level) activities in place**. All three had a strong 'peer review' approach, which could be seen as an emerging top assurance measure. Three most popular measures for quality assurance were: Peer reviews 18 (Out of the total 27 Analysed repositories used it); Expert review 17/27; User ratings 17/27.

Generic standards approaches are mainly ignored by the LOR managers/developers. Only three LORs used them as a basis for their quality assurance. Findings were that Generic quality approaches such as standards are not really considered by most repositories – they are seen as a costly, too complex solution.

"…we need to survive and we need to keep these kinds of cost as low as possible, otherwise it wouldn't live long. And all these kind of standards, they are, as I said, they are very good on the organizations that are rarely having big kinds of budgets, and you can explain a lot why you need additional money, but I don't think the sustainability is in that." -- Manager of Europe.National4

Overall popular among the federated repositories seems 'trusted networks' approach 6 out of 7 used it. This means that they claim to 'trust the content that comes in from the repositories that they harvest, saying ultimately that quality should be the problem of whoever is producing the content in the first place. This approach is understandable due to vast quantities of content being harvested by the repository – expert review for large amounts of data seems to cost too much, however this issue is also problematic because sometimes the quality simply is not checked at any point in the uploading process. Many of the LORs have an expert or expert board either hired or volunteering to check all content that goes into the repository. This quality approach takes a lot of efforts/funding to maintain. **The national portals run by the ministries of education seem the most sustainable regarding both their funding background and through that also their quality approach.**

The interesting case that does not fit the success pattern is "Europe.National4" repository, which has used only peer reviews as a quality assurance approach, but is still extremely successful initiative. For this we explored the interview transcriptions. Their peer reviewing technique seems to have been quite successful in the past:

"…for our free content we have already in 2001 to 2003, when we had a lot of free content coming in, what we did was that we called this process the washing day, so we invited any users, including pupils and teachers, whatever to check these contents and when they found a mistake, we gave them a prize. So this is… we "washed" the mistakes out of the free content, and this process was very successful, so we corrected thousands and thousands of mistake, including grammar and concept mistakes. So this is like a community checking, but no we are not doing that, these kind of large things anymore, because we do have very much free content coming in at the moment. " -- Manager of Europe.National4

However, when looking deeper into the case of Europe.National4, we can notice that their approach on motivating teachers to contribute towards resource contributions is unique among the evaluated 27 repositories – their salaries depend on how many international or national publications they make, which explains the success of their approach. Teachers all around the world would probably be motivated to contribute and re-use OER if their money depended on it. This country has put to place a '*reward system'* for the teachers, which seems to be one of the themes rising also in other interviews. Teachers would like to get something extra for their 'free work' if they are contributing towards or even using OER instead of normal course books. **LORs need new reward systems for contributions & publishing rate growth**. Perhaps the school world will soon move towards similar salary raises through publications as the academic world already has done for years.

"…I think we missed opportunities to reimburse good contributors, for example by awarding some "chocolate medals" to some good authors" — Technology developer of Europe.Thematic2

5.2 What is LOR success for repository managers/developers?

It's important to understand that quantitative metrics do not necessarily explain the entire success of the LOR (compare [49]). This finding regarding repository managers' point of view for success might be wider than user statistics; the repository **developers might see *additional success value (such as using repositories as test beds)***, which is not obvious:

"…Ok, it's not been THAT used, but nevertheless it is a success for me as it is, and also an element in the evolution of the community in didactics and education and among the secondary teachers, an evolution in the way they see resources and how to use them." – Technology developer of Europe.Thematic2

*"…**It is more like a learning lab for us**, it has allowed us to… we see ourselves as the premier curators of OER. We feel that we developed a lot of expertise of what is out there, and that our goal is to showcase that and to display dynamic ways, enable people to search through it fluently" --Technology developer of US.Federation1*

These examples would indicate that a repository might be successful even after contributions are not showing increases in use or content contribution. 'Being able to use LORs as testbeds' would fit under the Delone & McLean IS Success Model's construct "net benefits" [30][31]. Since the beginning of the OER movement, there has been some indication that Success indicators can also be tied together into user-generated quality instruments [22][7].

> *"Our main, what we are considering **criteria for success right now is user engagement.** -- Meaningful is for users to go through this facilitated evaluation process and evaluating large amounts of resources, so right now that's the big criteria, **the number of resources that get evaluated**." --Technology developer of US.Federation1*

This type of findings indicate that LOR success factors and metrics should be brought together to today's level. Many OER success reviews have been conducted more than 5 years ago, in which time the social media activities have changed the way users consume portals. Further research on this topic should be made.

6 CONCLUSIONS AND FUTURE WORK

This study reviewed both LOR quality approaches as well as their success factors and showed a clear connection between them. The key findings of this paper indicate that both specific top-down and instrument bottom-up user-generated quality level approaches are needed for maximizing the cost-effectiveness of the approach. However, generic standards quality approaches are often forgotten. It is vital to remember that user-generated quality assurance instruments can only make repositories successful if the community around the repository is strong enough to support it. Based on our findings the success of a federated LOR in most cases require expert reviews for all content coming in, however overall the most effective single approach seems to be peer reviewing the content. These research findings benefit developers and managers of LORs regarding the choices towards their quality assurance approaches. In this study we also touched the field of LOR success, which still seems to be somewhat in debate in the TEL research community. Regardless of many previous studies, there is still a lack of comprehensive Success theory for LORs, including solid success factors and metrics. This research identified the need for deeper understanding of what success is for repository managers, which should be studied further in the future.

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