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Digital Libraries - Advancing Open Science

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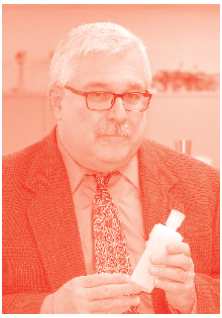



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Meet the editor

Sadia Vancauwenbergh is head of the Information Management and Strategic Data Analysis Unit at Hasselt University, Belgium, and Project Leader at ECOOM, an Expertise Centre for Research Development monitoring in Flanders, Belgium. She is president of euroCRIS, the International Organization for Research Information, and vice-chair of the International Society of Knowledge Organization – Low Countries Chapter. Dr. Vancauwenbergh's research interests are focused on Open Science and CRIS systems, particularly semantic interoperability. She was a member of the EOSC Working Groups for Landscape and Skills and Training and is a convener of the EOSC Association Task Force Semantic Interoperability. She is also a member of the Commission International/Federal Cooperation on Open Science, Belgium; the Flemish Open Science Board; and chair of the FOSB Working Group Metadata & Standardization.

Contents

Preface

Academic libraries traditionally contain collections of scientific research in support of higher education institutions' research and education and allow easy retrieval of the information by anyone interested. For several centuries, the collections contained in academic libraries consisted of almost entirely physical materials, be it in the form of books, manuscripts, articles, and so on. However, since the twenty-first century, digital material has been vastly outgrowing the traditional information resources of libraries, thereby shifting the focus of academic libraries from collection development to information access and digital resources. At the same time, this digital transformation opens numerous avenues for exploring and using information, and hence for supporting and advancing Open Science.

This book explores the process and procedures of digitization as well as the potential of using interactive applications in digital libraries, thereby raising possibilities to open scientific research to the world. Open Science, that is, the practice of science in such a way that others can collaborate and contribute under terms that enable reuse, redistribution, and reproduction of the research and its underlying data and methods, has greatly transformed digital libraries. As such, this book also provides an overview of the principles and practices of Open Access publishing, followed by a particular focus on Open Access books. it also describes how FAIR and Open metadata can act as leverage for digital libraries. The book concludes with a chapter on the possibilities of academic libraries to stimulate Open Education by means of supporting the development of collaborative and interactive open learning platforms.

I would like to express my sincere thanks to all the co-authors who contributed to this book.

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Section 1

Digitisation and Interactive Applications in Digital Libraries

Chapter 1

Evaluating the Processes and Procedure of Digitalization Workflow

Collence Takaingenhamo Chisita, Oluwole O. Durodolu and Joseph Ngoaketsi

Abstract

Digitisation is the practice of converting physical information into a digital (computer-readable format), by using digital technologies to modify the existing structure by enhancing the efficiency of an organisational process, foster reliability, and quality. This is a method of incorporating conventional records into a digitised form by eliminating redundancies and limiting the communications chain. This will help to improve accessibility and simplify better information exchange for users. The beginning of a digital revolution in any establishment is to appraise the manual methods with the view to improve and graduate to a user-friendly modern system. Digital workflow is a progressive, reliable arrangement of data, procedures, and responsibilities that make information is more permanent and management easy to access and enable the preservation of crucial data. This research set out to support workflow audit by revealing specific indicators to assist in processes that will enhance digital migration.

Keywords: digitization, access to information, library consortia, digital libraries, digitization workflow

1. Introduction

The essence of increasing the life span of information stored in papers containing resources of permanent value is to digitise. The pervasive and proliferating digital transformation requires organisations with the agility and the ability to react quickly to changes in the business environment [1]. Digitisation is an innovation brought about as a result of developments in computerised technology that can convert papers to an electronic format that is more permanent and devoid of environmental hazard that can eclipse the life span of information stored in the paper [2]. Theoretically, the procedure of digitisation entails converting an analogue image and other media its equivalent electronic format. In the context of this article, some of the vital issues like, the selection of documents, the scanning and image capture, arranging metadata and arranging for required hardware and software selection are essential for the development of digitisation workflow [3].

With the development of digitalization in full swing, many are pondering how the implementation of the new digital distruptive technologies will spur and inspire the creation of new jobs and destruction. The specific tasks that technologies take on and how many new jobs the created of others. Through the adoption of new digital technologies. Some maintained that most tasks that are at risk of automation are those performed is an area for concern for policy makers in government, industry, higher education and civil society by rather low- to medium-skilled employees, while most new tasks that emerge from the adoption of digital technologies complement high-skilled labor [4].

Elaiess [5] and Arms [6] viewed a digital library as a systematically managed collection of information with allied services, where the information is stored in digital formats and reachable over the Internet. Witten and Bainbridge [7] highlighted the following as the key features of a digital library:

1. Prearranged and managed a collection of digital objects;

2. Available, accessible or obtainable over the Internet or server;

3. A universal information infrastructure; and

4. Provides service to users.

Kane et al. [8] defined digital maturity as the extent digitisation has transformed the processes, talent engagement and business models of an organisation. The indicators of including, digital maturity include;

1. The clear and coherent digital strategy incorporated, with the ability to articulate the value of digital technologies to the organisational future;

2. Comfort in taking risks and embracing failure as a prerequisite for success; and

3. Investment in organisational capabilities.

Shuva [9] argued that in the era of digital technologies, a digital library has become one of the most frequently used terms in the library and information science arena. Digital libraries have become the magic bullet to rescue governments, academic institutions, industry and users from the COVID-19 pandemic regulations which prevents physical contacts and encourages social distancing. Such techno-centric institutions refer to systems that are very heterogeneous in scope and provide different functions. These systems range from digital objects and metadata repositories, reference-linking systems, archives, and content administration systems to complex systems that integrate advanced digital systems [9]. Libraries are information systems whether traditional or modern because they collect, process, store, analyse and disseminate information for specific purposes to specific user groups [10].

Tihinen et al. [1] viewed digitalisation as one of the prominent trends transforming the information landscape, society and business in the near and long term future. Digitalisation refers to the action or process of digitising; the conversion of analogue data into digital form [1]. Digitalisation is the critical enabling issue for providing internal efficiency in organisations, or for delivering external opportunities such as new services or offerings to customers [1]. The use of various digital technologies has become a core mission of libraries and related institutions [11]. Belhi et al. [12] argued that the wide adoption of information technology obliges organisations to adapt its resources to be part of the digital era. According to the authors, the high development pace of technology has resulted in the fear of digital obsolescence as a critical factor than the fear of physical data loss. Digital obsolescence, or data extinction, refers to the state whereby the archived data becomes no more readable or usable [12]. The files meant to be read or edited with a certain programs (e.g. Microsoft Word) might be illegible in other programs, and as operating systems and hardware changes, even old types of programs developed by the same company become difficult to use on the new platform.

Libraries as cultural institutions accommodate treasured documents, as a result, must carefully consider digitisation as a way to preserving the information resources to circumvent the loss of the originals, this is the position of modern librarians. Usually, in the library environment, digitisation comprises of scanning, photographing analogous pieces like cherished books, maps, manuscripts, correspondence, which are considered but not limited to as rare, exceptional, and tremendously delicate collections, and then transforming these resources into a digital environment where the lifespan can be permanent and the integrity preserved [13].

Digitalisation has many recognisable advantages such as instant accessibility to information, easy and speedy communication and capacity to share and exchange information, the generation of new jobs, better opportunities, and increased transparency and visibility [14]. The aim of digitisation is to improve access and advance preservation [15]. Digitalisation enables libraries and related institutions to provide virtual access to content in order to ensure the discoverability and the retrievability of the content and enhance the preservation of the content by avoiding the wear and tear of original works. The proliferation of digital technologies and the drive towards the fourth industrial revolution (4IR) should be viewed as an opportunity for libraries and related institutions to improve services to users by responding to their dynamic needs by adapting the innovative emerging digital technologies including Virtual Reality (VR).

The Digitization Workflow is an approach to explain the step by step arrangement of digitising information resources to accomplish the process of digitisation including its various phases, like the process of material selection, preparation of documents, scanning/OCR use scanner, processing for editing, quality assurance, metadata and indexing, back-up and archiving, publishing in a digital repository and finally checking out. The rationale of this workflow is to provide history tracking of actions and flexibility to accomplish multiple projects with multiplicity and diversity of materials concurrently. Additionally, it supports the convinient assimilation of tools used to implement the functions of the workflow. Optical Character Recognition (OCR) is a technology that allows the conversion of diverse types of the documents and materials, such as PDF files or images captured by the use of a digital camera into editable and searchable data formats [16].

The first stage of digitization is document selection which requires expertise in knowing which documents to include and for what reasons. The preparation of document is key to enable selected documents a flawless procedure that is devoid of office objects such as: document clips, sticky notes, pins and spiral bind. Scanning/OCR (Optical Character Recognition) is the conversion of physical documents to electronic format which requires the use of highly efficient, reliable and speedy electronic scanning machine. Optical Character Recognition is used in converting images, handwritten or printed text into machine-encoded text, whether from a scanned document, this is important because it will make the document searchable and easy to locate and retrive from online. The integrity of the document it is of paramount importance in order to ensure quality assurance of the document by properly editing the information content so that the document will be free from both content and grammatical errors. The final stage of the digitization process is to ensure back-up and archiving this will guarantee the security of the document and information content, in case of hacking, social engineering, cross-site scripts virus attack or other unforeseen problem that might compromise the integrity of the document [17]. These are the step by step

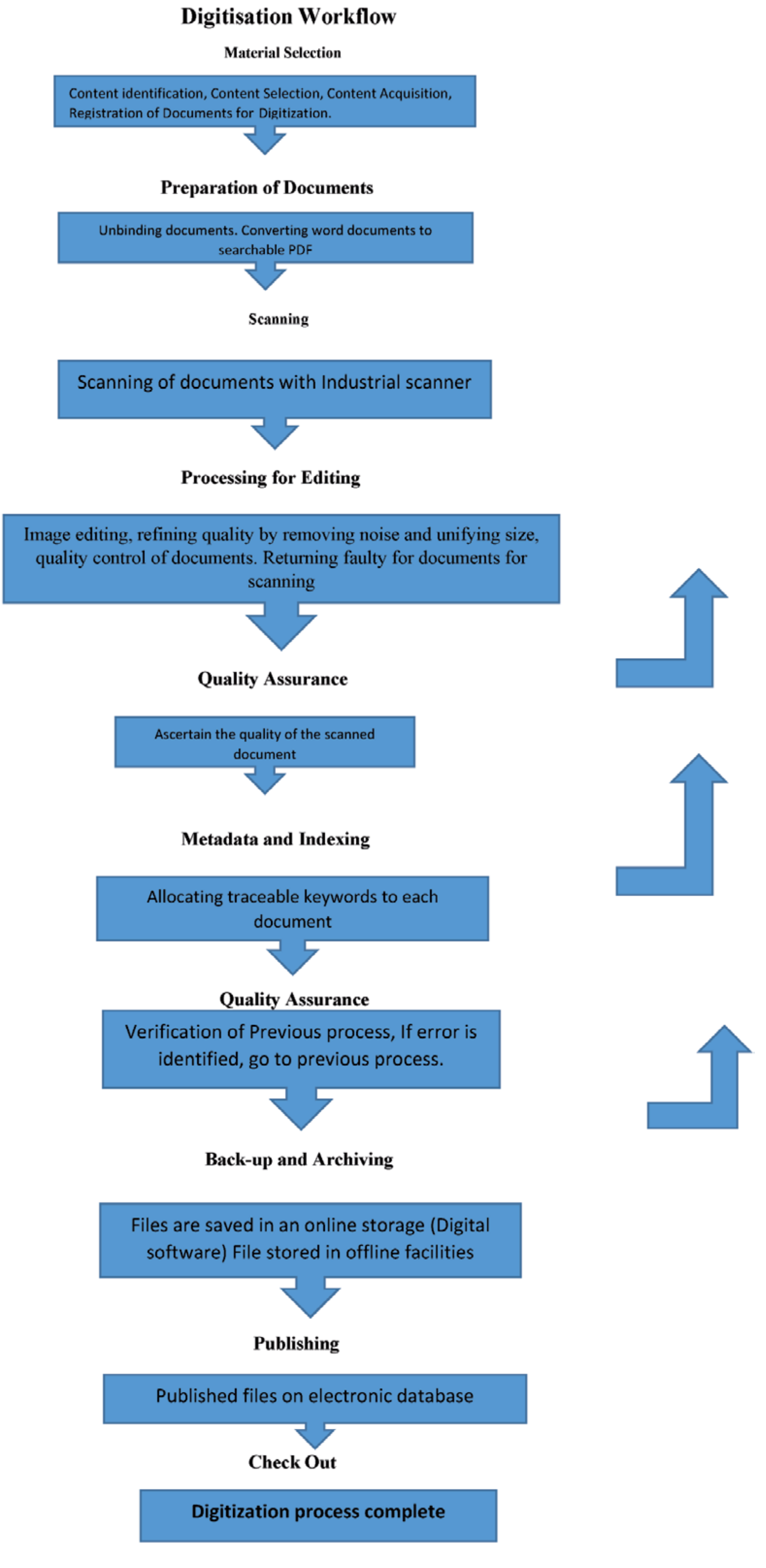

Figure 1.
Digitalisation workflow chart.

procedure of digitization workflow before finally publishing the content to make it visible within the local network and its availability and accessibility on the internet for the benefit of the general public (**Figure 1**).

The Digitization Workflow is an approach to explain the step by step arrangement of digitising information resources to accomplish the process of digitisation including its various phases, like the process of material selection, preparation of documents, scanning/OCR use scanner, processing for editing, quality assurance, metadata and indexing, back-up and archiving, publishing in a digital repository and finally checking out. The rationale of this workflow is to provide history tracking of actions and flexibility to accomplish multiple projects with multiplicity and diversity of materials concurrently. Additionally, it supports easy assimilation of tools used to implement functions of the workflow. Optical Character Recognition (OCR) is a technology that allows the conversion of diverse types of documents and materials, such as PDF files or images captured by the use of a digital camera into editable and searchable data format [16].

Abollado et al. [18] noted that while digital workflows are a suitable solution for managing business processes complexity in the engineering industry, it is equally essential to be aware of all the challenges that are associated with implementing a workflow system. Such grandiose projects require concrete management engagement, end-user involvement, tools and system integration and a sensible implementation plan. Abollado et al. [18] observations were drawn from the engineering sector, but they apply to library science with regards to the ongoing digitisation projects.

Digital workflow projects underpin organisational performance. The previous phases of a workflow project are generally more critical to the overall success of the project. There are several recommended practices for implementing a successful workflow management system in an aerospace company, for example, obtaining the support of senior management, integrating the digital workflow with current techniques and securing the support of end-users who are also key stakeholders [18].

The digital workflows and workflow management tools offer an opportunity to improve, automate and streamline the underlying processes in any business, including the library [19]. Such projects help to enhance communications, among others, benefit—performance, accountability and visibility. The essential criteria for selection for digitisation are the copyright status of the original materials. Images are supposed to have their copyright held by the establishment. If the organisation does not have the right to digitise, then other images must be chosen, or the project cannot proceed for fear of litigation. Preparation of the digitisation process includes reviewing the procedures in place from the beginning to the end of the process of production facility up to the final delivery digital images and data back. Other important aspects of the digitisation workflow includes generating indexing and keyword to includes convinient information accessibility and precision. It is vital to ensure quality control so that the output will be acceptable to the general public and meet international standards. To securing data and enable the integrity of the information is vital, data encrypted and securely kept to guard against loss of information [20].

2. Digital preservation challenges

Content digitalization has becoming an established enterprise in the information age, giving birth too many innovative business ideas, models and much more. This has led to numerous disciplines and industries taking advantage of its opportunities and broadening and widening access to organisational resources. As a result of several advances in information and communication technologies many organizations have adapted to digital models driving the new digital era.

The general misunderstanding is that to digitize a material is the same as digital preservation. To digitize material is the act of converting something from an analog to a digital format. For instance, scanning a photograph and retaining a digital copy on a computer. This is basically the first step in digital preservation. To digitally preserve a material is to prolong the content over a long time [21].

Several galleries, libraries, archives, and museums (GLAMs), and other cultural institutions, undergo uphill task catching up and up to date in digital preservation. Digitization is a onerous and time-consuming activities, mostly because it is contingent on the critical condition of the holdings previous to the time of digitized. The possibility exist that the materials may be fragile and delicate that if care is not taken the information resources may be lost or become damaged irreparably; light emanating from the scanner can destroy old photographs papers and documents. Notwithstanding the potential damage, one rationale for content digitization is as a result of constant use of a material, therefore, digitization will preserve the original copy from total degeneration [22].

The process of digitization is relatively expensive. Organizations ensure best quality in digital copies by retaining the best possible. Raising money to meet the expense required for the equipment is another major challenge. The quality of personnel may also limit the process of digitization. Archivists and librarians must be familiar with the aspirations and desires of their patrons and try to prioritize and meet the needs digitally [22].

3. IFLA guideline for digitization

The International Federation of Library Associations and Institutions (IFLA, 2000) [23] a foremost international body representing the interests of libraries and information professionals, in a report in 2000 identified guidelines for digital project, which has become popular in setting standard for the implementation and practice of digitization. Regardless of this standard, studies of digitization shows that it is rarely utilized as standards for evaluation [24].

4. Process of selection for digitization

The formulation of selection policies is a fundamental element of digital schemes, and various selection guidelines and standards have been established by organizations to authenticate their selection processes for digitization regarding external benchmarks, particularly with the growth of partnerships for digital projects. It is important to prioritize the materials to digitize based on the need of the patron, usage of information material is an alternative factor which helps to decide a collection's priority for digitization [25].

5. Technical requirements and implementation

The technical Standards for digitization requires to sourcing records in line with best practice and technical standards when the digitized record is projected to stand in place of the source record as the official record of information resources [26].

There are steps to follow in the implementation of digitization projects, determining the vision for implementing digital transformation, analyzing the market by determining the needs of the patron because of quick technology improvement and industry modifications, are crucial for creating the appropriate and up-to-date strategy. Another step involves assessing the a current standing which is a way to evaluate what technology to update and to identify what digital tools to change will help in prioritizing the efforts and investment in digital transformation strategy in the best possible way [27].

6. Using the system development life cycle for understanding of digitization process

Elaiess [28] and Elaiess [5] viewed the standard development life-cycle (SDLC) as a means to provide the standard methodology and high-level operational guidelines within which software is developed and maintained. It is the process of understanding how an information system can support business needs, designing the system, building it, and delivering it to users. Cervone [29] argued that the system development life-cycle concept had been applied mainly to system development projects for years. Project teams developing digital library systems can be more effective if they understand the expectations and outcomes of each phase of the system development life-cycle [29]. Systems development is the art and science of creating human made information systems to satisfy predetermined needs. The systems development life-cycle can be used for the traditional and the modern library materials with regards to creation, processing, dissemination and preservation. It is a problem-solving process integrates appropriate elements of humankind's knowledge base to create new knowledge specific to the problem and, as a result, define a solution to the problem. Grenci and Hull [30] highlighted that Information systems development methodologies (ISDM) encompass the sum total of methods that are used for developing and implementing information systems applications. The use of information systems in the organisational environment has been growing in recent times, and this justifies the need for broadening and widening understanding of how such systems operate and how they can benefit libraries and related institutions.

Duarte and Costa [31] viewed Information Systems as important tools to enhance the efficient management of information and other knowledge assets in organisations. The life cycle model is very important because each phase of the process influences the phase after, which means that phases of the life cycle have a great influence on the global success of these systems. Duarte and Costa [31] argued that it was vital to know all the process and its critical success factors to make sure that there are no mistakes. The systems development life cycle must be understood because it underpins the success of a library digitization project. The digitization of libraries is now on the agenda of many academic institutions and governments especially now in the era of the COVID-19 pandemic. The aforementioned processes and procedures of digitalization workflow are useful for the development of digital libraries in the era of the COVID-19 pandemic.

7. Conclusion

This article presents a substantial academic work highlighting different phases of digitization workflow and the process of electronic or digital conversion of documents. Digitization is important because it helps to enhance data processing, improving data storage, fast-tracking transmission and improving efficient service delivery. It also facilitates data sharing and retrieval, and it has proven to be the most satisfactory way of preserving information for a considerable length of time. This research also simplifies the chain of processes and tasks involved in a digitization project, thus facilitating uniformity and dependable results relating to the digitisation of a large volume of objects. It should be noted that the documentation of the workflow is critical for tracking material within the context of a series of the stages of the process and identifying technical glitches. This article also highlighted some of the challenges of digitization. For instance, damages caused by environmental problems like, earthquake, rainfall, humidity, fire, and other human factors like careless handling, defacement and inappropriate support during storage and cyber threats. The deterioration of library resources like books, journals, and other materials forms the fundamental challenges of libraries which makes preservation and conservation imperative. Finally, this study also revealed the digital lifecycle and its phases through which digitization process go through to attain full conversion and this is the passage of modernization that pursues constant regulations to attain innovative expectations.

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Chapter 2

The Interactive Applications (IAs) in Academic Libraries: Challenges and Opportunities

Husain Ghuloum and Zuwainah Al-lamki

Abstract

Presentation tools of academic content are increasing in popularity for educators in Higher Education Institutions (HEI) who want to share ideas and information in a more creative and interactive environment using more effective tools and demand to involve. Interactive Applications are becoming lot more common and is more integrated into our everyday activities, like using mobile apps. The features of the Fourth Industrial Revolution (4IR) began to emerge through Interactive Applications (IAs) such as the applications of Augmented Reality (AR), Virtual Reality (VR), Mixed Reality (MR). Information resources development is no longer restricted and residing within the realm of speculative fiction. By using AR, VR and MR, academic libraries could already deliver a massive revolution in information retrieval. However, the biggest challenge that need to be tackled perhaps remains in how we could tune between these resources and the users so that the greatest possible benefit could be achieved in the light of accelerated technological development. This chapter uncovers the challenges and opportunities in using Interactive Applications (IAs) technologies and should be an eye opener for academic libraries that Interactive Applications technology are important to transform the use of traditional resources to interactive resources.

Keywords: Interactive Application, Virtual Reality, Augmented Reality, Mixed Reality, Academic Library, Open Science, Interactive Information Resources

1. Introduction

Interactive Applications (IAs) are becoming lot more common and is more integrated into our everyday activities. The ability of IAs to enhance what already exists is what makes it an ideal fit for libraries, educational institutions, museums, and similar institutions. It can be used for resources wayfinding, shelf-reading, upgrade services, technological integration, and community engagement. New technology services are making it easier than ever for libraries to create their own free or low-cost IA content without having to download a Software Development Kit (SDK) or transact with complicated Application Programming Interface (API) codes [1]. In addition, the development of open science (OS) movement and methods has supported scientific research data and has managed to make its information accessible to the scientific society and to the overall public. This wide global recognition towards OS has made the demand of making data more open through important aspects such as open data, open access, open material, and open educational resources to sustain sharing scientific information easily. And by IAs such as AR, VR and MR, this type of information can be experimented easily and used firsthand by users in academic libraries.

2. The concept of interactive applications (IAs)

An Interactive Apps (IAs) is an application that allows users to interact with audiovisual information via gamification, visualization, and even Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR). The origin of Interactive Applications such as AR, VR came way back in 1838, when Charles Wheatstone invented the stereoscope [2]. **Figure 1** shows the timeline of Interactive Applications by checking out this infographic, which details not only the technology's past but also its present and future [3–13].

2.1 Augmented reality (AR)

Augmented reality (AR) can be defined as *"an enhanced version of the real physical world that is achieved through the use of digital visual elements, sound, or other sensory stimuli delivered via technology"* [14]. Furthermore, AR is a system that fulfills three basic features: a combination of real and virtual worlds, real-time interaction, and accurate 3D registration of virtual and real objects (see **Figure 2**).

2.2 Virtual reality (VR)

Virtual reality is one of the most popular technologies currently, which can allow experiencing things that may be difficult to happen in the real world. VR can be defined as *"an artificial environment that is created with software and presented to the user in such a way that the user suspends belief and accepts it as a real*

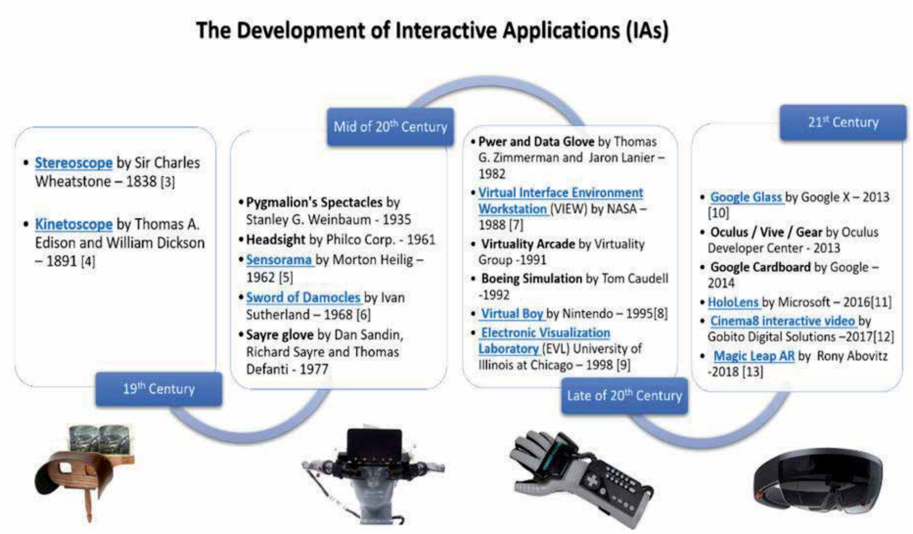

Figure 1.
The development of interactive applications (IAs) [3–13].

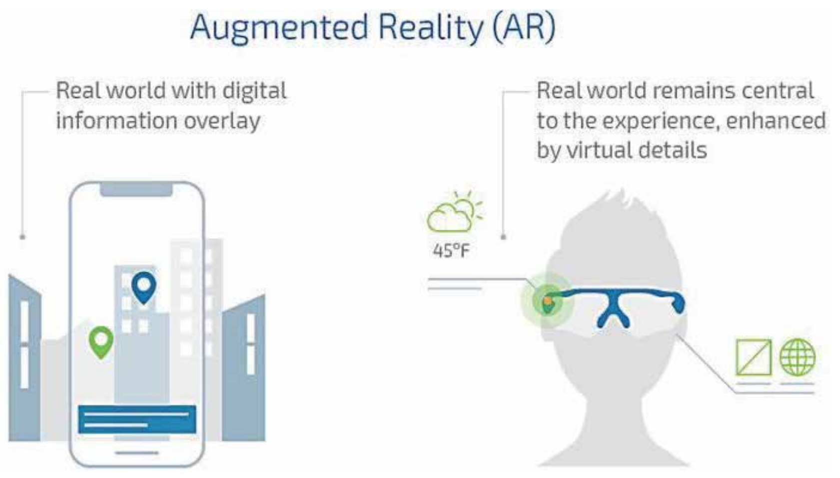

Figure 2.
The concept of augmented reality [15].

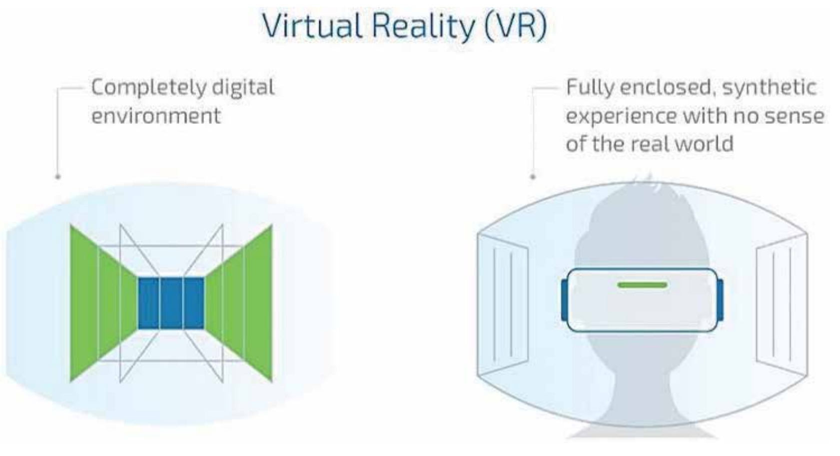

Figure 3.
The concept of virtual reality [15].

environment" [14]. Furthermore, it is the computer-generated simulation of a three-dimensional image or environment that can be interacted with in a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors (see **Figure 3**) [15].

2.3 Mixed reality

Mixed Reality, also called the merged reality, is a term coined by technology giants Intel and Microsoft to describe their proprietary VR project. MR is defined as "*the merging of real and virtual worlds to produce new environments and visualizations where physical and digital objects co-exist and interact in real-time*" [16]. **Figure 4** indicates Mixed reality takes place not only in the physical world or the virtual world but is a mix of reality and virtual reality [15]. Simply, Mixed reality is a hybrid of VR and AR and aims to offer the best of both worlds. For instance, while it uses a headset just like VR, seeing through a translucent viewport or glass, it also projects visuals on top of our environment.

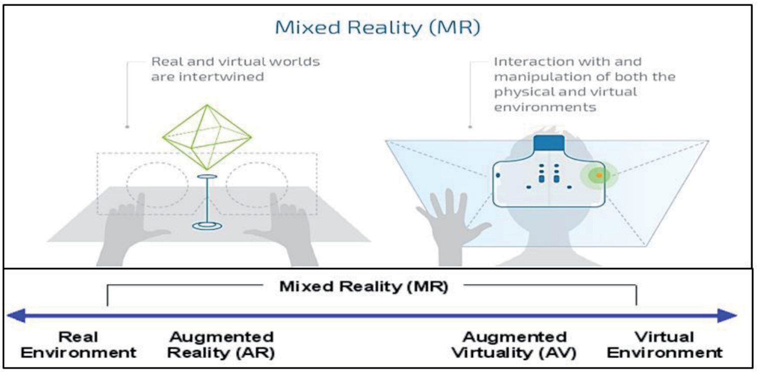

Figure 4.
The concept of mixed reality [15].

3. Interactive applications (IAs) in academic libraries in the digital age

Forty years and more the future of the library has been questioned by people, in addition it has been predicted by some the end of the library. This is due to being incapable to deal with the digital and social transformation, unsustainable by the classic Gutenberg era; having made a dead end, they "may disappear like the dinosaurs" [17]. But one thing is for sure, which is the development of the modern world of information technologies and digital developments, connectivity has changed the future advancement of libraries, and libraries must offer advanced solutions if they want to exist. Integrating IAs, such as VR, AR, and MR into higher education institutions and their libraries, are essential to the advancement of learning in the digital age. Advanced learning platforms through technology are already available and in higher education, their use is catching on. In fact, the use of IAs is already becoming more popular in higher education. Since 2015, for instance, first-year medical students at Case Western Reserve University have been learning from home using an MR app called HoloLens and Holo-Anatomy, created by Case Western Reserve University and Cleveland Clinic in cooperation with Microsoft. Through 3D learning, medical students are learning about the human body in a way that would otherwise not be possible [18]. Similarly, San Diego State University Instructional Technology Services has used virtual immersive teaching and learning since 2017. Students' learning is enhanced through the opportunity to interact with 3D graphics in what appears to be a real-world environment. Instead of placing the student or a camera within a physical learning environment, virtual reality places the student in a simulated environment where senses such as vision, hearing, and touch foster learning.

In 2015, the University of North Texas (UNT) Media Library began offering access to VR and AR devices. This collection is growing as new technology, games, and devices evolve to support students, faculty, and staff interested in research and recreation. IA's in UNT Media Library can be used for various forms of simulations and entertainment, for instance, by using VR headsets such as HTC Vive to let students walk around 3D visualizations or reconstructions of archeological sites. Moreover, museum visits, view artwork from different angles or up close, or view designs in 3D and gain a better understanding of how they work [19].

Two years later, in 2017, Harvard University Library opened the AR/VR studio to further the growth of the ventures being built at Harvard using inspiring AR, MR, and VR tech, as well as, to give students from across the university a space to experiment with and create projects and ventures in the virtual, augmented, and mixed reality spaces [20]. In the same year, North Carolina State University (NCSU) Libraries launched the Virtual Immersive Teaching and Learning (VITaL) initiative, providing a variety of VR, AR, MR, and 360°-video immersive tools for use across the NCSU pedagogical spectrum. Today, "VITaL serves as an incubator to enable experiences that would be out of reach, if not impossible in a traditional learning environment, including low-frequency, high-risk scenarios simulating life-threatening medical conditions, celestial events in outer space, and scientific phenomena occurring at the micro scale" [21]. Thus, there are many university libraries around the word have used these technologies to enhance their services and functions. Hence, information resources development is no longer restricted and residing within the realm of speculative fiction. By using IAs academic libraries and learning centres could already deliver a massive revolution in information retrieval. However, according to Rotolo, Hicks, & Martin, (2015) the biggest challenge that needs to be tackled perhaps remains in how we could tune between these resources and the users so that the greatest possible benefit could be achieved in the light of accelerated technological development. Given the perceived lack of available research material regarding the impact of emerging technologies in real-life application since they are new and still developing [22]. This development of information resources leads the researchers to introduce a new term titled Interactive Information Resources (IIR).

3.1 The definition of interactive information resources (IIR)

Ghuloum, Allamki, and Alhabashi, during the Digital Transformation Conference in the State of Kuwait in 2018, presented a new concept of IIR which is;

"a type of electronic resource that is faster and more flexible in information retrieval than both the traditional and the electronic information resources due to the wearable form-devices and its complex algorithms. It is used to instantly map your information environment to create photorealistic, shareable, and collaborative 3-D digital models of the contents" [23].

The wearable devices and software incorporate digital and holographic data into the real-physical environment and streamline existing use of the information resources processes in a collaborative context to enhance and empower the experience of the beneficiaries. In other words, it is a way to simulate the content of traditional resources into an augmented electronic environment, where the new shape of the content could be interactively browsed using the physical hand-waving of users. Information resources, over the time has gone through many changes, starting with Traditional Information Resources (TIR), then Electronic Information Resources (EIR), and finally Interactive Information Resources (IIR). **Table 1** clarifies the comparison criteria between the different types of information resources.

3.2 Open science and IAs

The importance of the resources is determined by contribution and sharing. In other words, sharing of information is part of the basic principles of libraries, therefore, librarians and other information specialists must provide access to information in any medium or format for library users. They also encourage the concepts of open access, open source, and open licenses [24].

Throughout history, scientists develop the best research by building on the work from others. The essential role of accessible information in the development of science and technology naturally gives growth to the Open Science (OS) movement that aims at disregarding access barriers to scholarly communications (Open Access,

Information resources (IR) criteria	Traditional information resources (TIR)	Electronic information resources (EIR)	Interactive information resources (IIR)
Multimedia	Static	Dynamic	Interactive
Browsing Speed	Slow	Fast	Instant
Collaboration	Not Supported	Not Supported	Supported
Content	Printed	Electronic	Photorealistic
Sharing	Not Possible	Possible	Possible
Accessibility	During working hours.	24/7	24/7
Update	Slow/Easy	Fast/Easy	Fast/Hard
Space	Require large physical space.	Require reasonable electronic storage.	Require large electronic storage.
Information Literacy	Knowledgeable	Widely knowledgeable	Lack of knowledge
Cost	Reasonable	Reasonable – Expensive	Very Expensive
Maintenance	Low	Medium	High

Table 1.
Comparison IR criteria between TIR, EIR and IIR [23].

OA), research data (Open Data), and the proprieties and other software tools that gather and process the data (Open Source) [25].

Research contributions are recognized in the age of OS by the way how technologies have changed [26]. For instance, scientific literature contains acknowledgments and comments that are a form of peer reviews on the cited work. Even, software and datasets are cited work too and not only articles.

OS is a movement to make scientific research, data, and spreading accessible at all levels of an investigative society. It is also a transformation of an approach of how research performed, documented, and distributed. The goal of OS is to make research outputs; methods and software are openly accessible. It can be well-defined as a sequence of procedures that, under the proper requirements, it improves the quality of research by making results shared and accessible. One of the main qualities of OS is sharing research data among researchers. Therefore, the advancement of OS affects various strategic, theoretical, and technical disputes to numerous scientific societies that carry out data-driven research [27].

3.2.1. Open science researchers

There are career-driven essential reasons to apply and promote OS methods. Besides there are benefits that specifically involve those who perform the research that are known as Early Career Researchers (ECRs). Generally, OS methods are expected to address concerns around duplication, are progressively expected, and ECRs can gain from being involved early on [28]. Thus, the OS movement provides opportunities to access unrestricted high-quality data. During the past years, the world has witnessed outstanding technological developments, specifically in the field of artificial intelligence (AI) power-driven by the access to big data and cloud computing [29, 30].

OS methods is known that it could improve the quality and consistency of scientific work. Such methods that are developed become extensively recognized, in addition ECRs who adopt OS early, the progress of the research should reflect confidently in the quality.

An important aim of the OS movement is to make science more reliable and trustworthy. Sharing of procedures and data leads to repetition, reproduction of analyses, and exploration. This increased exploration can also be an influence to guarantee good quality data and analyses [28]. In addition, in an educational prospective, once code and data presented the researcher replicate results presented in papers, which simplifies understanding of the study. Scientists and public at all levels can benefit when replication of results found, as it is crucial to OS and vital in increasing trustworthiness.

Furthermore, for researchers to promote collaboration among them, configurations must be established around OS. These configurations include a variety of software tools, and publishing mechanisms. OS software such as web-based, version-controlled repositories like GitHub archivist [31] can help with maintaining and sharing code. In other words, ECRs can form well-documented and strong code where libraries that may use over again for impending studies and for educational purposes [28]. Therefore, new open tools can help with strong data analysis in a manageable manner.

Placing more research and data in an unrestricted domain is fundamental to OS and increases ECRs' opportunities for recognition, interchange, collaboration, and development. Moreover, articles that are published and share open data by researchers obtain more citations than articles that do not share data [32], thus, ECRs can obtain citations for their work when deposited at unrestricted open repositories such as the OS Framework. Setting research and data in the public domain is essential to OS and increases ECRs' opportunities for recognition, exchange, and cooperation [33].

Early implementation of OS practices encourages and drives career advantages for researchers in the future. With open data, it is open to everyone, therefore, OS can expedite wide contribution for ECRs and to the public in general. And therefore, early OS implementation will have equal benefits for science and to the public.

3.2.2. IAs platform as a tool for open science in academic libraries

Cloud-based technologies have become an important tool and are extensively used by scientists all around the world to perform their research. The European Open Science Cloud (EOSC) is supported by the European Commission as a source for advocating OS and research. Cloud resources are raised according to different usage patterns, and decreased costs for individual groups of scientists to sustain their own foundation, therefore, they can be delivered up on request [34].

In Europe experts outlined the basic principles of the cloud of OS for the European Open Science Cloud (EOSC) [35]:

1. Other electronic infrastructures and projects are needed to be combined with EOSC by establishing organized system of services and information that suits the centralized standard.

2. The accessibility of services and data in agreement with applicable and non-biased policy describes the term "open" (although not all data and tools may be open nor the existence of free data and services).

3. EOSC-hub should include academic fields in its cloud.

4. The term "cloud" should relate to worldwide access to scientific data, software, standards, expertise, and policy frameworks and not to ICT structure.

Most participants for the European Open Science Cloud (EOSC) agree in the fact that this cloud needs [36]:

1. Different suppliers should provide the system of services.

2. The developer efforts should concentrate on the integration of cloud services, therefore, depend on current electronic infrastructure.

3. New services should be freely distributed to users developing and incorporating new services and tools when they are available.

4. To make it a primary motive for the development of the European cloud of open science by prioritizing the needs of users.

To solve research difficulties, modern science need support from computing societies, consequently many European and national associations deal with cloud-based infrastructures. One of them is the European Network Infrastructure (EGI). European Network Infrastructure (EGI) is an innovative computing engine for research designed to improve computing services for research. The state primarily funds the EGI and has over 300 data centers and cloud providers all around the world. Open academic community is its basic principle, open results for research and research infrastructures is its mission and that is by establishing and providing openness through combining digital abilities, resources, and knowledge between communities and across national limits. EGI structural design is organized in platforms [32]:

1. Managed distributed infrastructure is a basic Infrastructure Platform.

2. Managing the merging of Cloud infrastructure and regional infrastructure.

3. Easy access to large and distributed data sets is provided by an open data platform.

4. It is a platform for the exchange of information, collaboration, and community coordination.

5. Cooperative platforms and specialized service are designed for certain academic communities.

The most common area of OS in many academic and research institutions have actively engaged is Open Access (OA). OA to scientific peer-reviewed publications has led the trend of OS, which is now also expanding to original research data. Still, there are some difficulties to OS, which now impede the full understanding of its benefits. In theory, OS includes the public spread of all aspects engaged in scientific investigation, ranging from lab journals and research notes to publications, materials, data, methods/protocols, models, code, and software [37]. Although not all these aspects may be freely available in all cases, a commitment to enable the sharing of these resources reinforces the OS movement. OS is new to all academic institutions even in one of the world's foremost research performing academic institutions which is UCL (University College London), nevertheless, this structure supports the leadership role of the Library [38].

- **UCL's Open Science Policy Platform**

Open Science is a growing area, and it is a challenge in how universities and research institutions can co-operate with it. A new role for the academic library has been developed in sharing research and informative outputs. In other words, the academic Library is now more than a supervisor and a cataloger of information. The Library provides access to data and information, which allows for the integration and creation of new knowledge. This new role of the academic library is also played in part by the research coordination office and places it directly in the frontlines of these developments at an institutional level to create new methods to the delivery of OS such as UCL (University College London) experience [38].

University College London (UCL) has initiated an OS Policy Platform. It is directed by the Pro-Vice-Provost (UCL Library Services). The purpose of the Platform is to look at the institutional approach and to distinguish areas which would promote from configuration with the concept for OS. In terms of application, the Platform has found 6 main sections for preliminary action and implementation:

- Open Access and OA Publishing
- Bibliometrics
- Research Data Management
- Recognition, Promotion and Reward Structures
- Open Education
- Citizen Science

The Pro-Vice-Provost works with existing committee structures in UCL to promote open methods and to utilize the applicable e-structures to convey open pursuits in each of these sections [38].

4. Challenges and opportunities of IAs in academic libraries

To implement a new technology in academic libraries such as IAs, we need to understand the strength and weakness aspects in this type of technology. Hence, **Figure 5** presents the challenges and opportunities of IAs in academic library.

4.1 Challenges

- *Security and Privacy*:

Although the development of IAs provide great benefits, the practical use of it in academic libraries require user acceptance. One issue with respect to user acceptance is preserving ethical issues such as security and privacy. Privacy and security strategies need to consider different aspects, including the ability to gather user information, using IAs information provided by third parties, the ability to share these systems, and providing security in the environment of these applications.

- *Network Issues*:

The network is an important part of IAs architecture in academic libraries, which provide a connection between the users and the server via a configuration

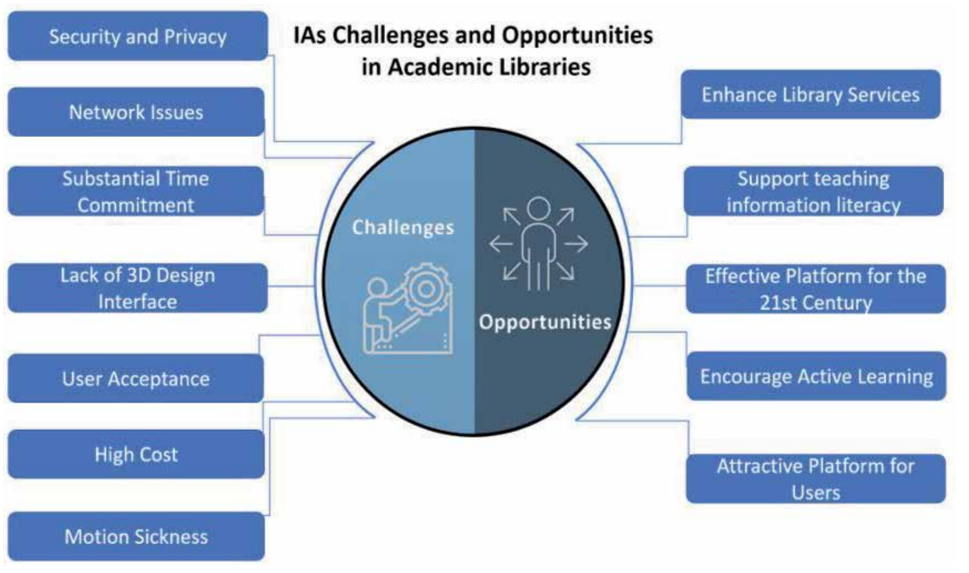

Figure 5.
IAs challenges and opportunities in academic libraries.

mechanism. When the IP of the network is achieved, each user can communicate with others and the server to access the IAs package containing the virtual model [39]. Hence, network issues may be an obstacle to implement IAs in Academic Libraries.

- *Substantial Time Commitment*:

Substantial time is required in using IAs technology and related hardware/software and creating services for academic library users. Many librarians may find this process too time consuming and lacking in added value [40]. Towards OS, there are theoretic reasons why OS methods could save time. Nevertheless, these reasons hardly come to completion in the existing system. The additional requirements for research that use the OS method often take more time, this all goes back to the traditional procedures like Archiving, documenting, and quality controlling of code and data [28].

- *Lack of 3D Design Interface*:

The biggest barrier to wide adoption of immersive IAs in academic libraries is the lack of good user experience design. 3D interface design is difficult and expensive, and there are few people with the necessary design skills to overcome these issues [41].

- *User Acceptance*:

Getting people to use IAs such as AR and VR may be more challenging than expected, and many elements play a role in use acceptance of IAs ranging from unobtrusive fashionable appearance (gloves, helmets, etc.) to privacy concerns [42].

- *High Cost*:

The market indicates that, IAs equipment and devices are costly, which is hard for the academic library to balance between the number of equipment and user demand. Furthermore, the IAs such AR, VR and MR industry are developing fast, which leads libraries to keep up to date with these changes. In addition, maintenance and repair cost can be another challenge for libraries as some of them have limited budget to afford acquiring this type of technology [40].

- *Motion Sickness*:

Several studies confirm that, some people experience motion sickness in VR and MR which means when they put on a headset and enter a virtual world, they feel dizzy or nauseous. This challenge makes decision-makers in academic libraries hesitant to acquire IAs [40, 42].

4.2 Opportunities

- *Enhance Library Services*:

IAs contribute to improving the quality of services provided by academic libraries to users. For instance, Indiana's Premier Urban Public Research University (IUPUI) believes in the power of transformation. They are committed to providing educational opportunities that transform the lives of students, community, and the changing world. Therefore, the IUPUI University Library provides a Virtual and Augmented Reality Lab (VR/AR Lab) that has been provided through a generous federal grant from the Library Technology Services Act. The VR/AR lab includes two HTC Vive HMD's, an MSI VR One backpack PC, and one META 2 developer kit. The lab is available to all students, faculty, and staff of IU to experience and gain a better understanding of this emerging technology [43].

- *Support Teaching Information Literacy*:

IAs such as VR, AR, and MR are valid additions to the toolkit that may be used by Academic libraries to engage its users, not only with the latest technology but also with the goal in mind of ensuring a proper approach to teaching information literacy. Users such as students will gain immeasurably from the enhanced delivery of information on a particular topic through IAs and the multiple means by which the student can become proficient in the basic information literacy skills culminating is successful search for information, using every tool at his or her disposal to complete their academic assignments [44].

- *Effective Platform for the 21st Century*:

There are many opportunities for implementing IAs technologies into today's and future academic libraries which closely match the life and education styles of Generation Z users. That lead several academic institutions to acquire IAs equipment and devices in their libraries such as Harvard university library, Cleveland state university library, and others [40].

- *Encourage Active Learning*:

IAs technologies support the active learning style in academic libraries which is becoming popular among the current academics in most disciplines. For example, Microsoft is showing again how HoloLens can help engineering designers via collaboration with the University of Cambridge's construction IT lab. "We have never been able to bring 3D models from buildings and bridges off our screens and onto the real structure," says Cambridge's Ionnis Brilakis. Using the HoloLens, however, engineers can overlay a design onto a real-world bridge or building (or vice-versa), making inspections simpler and safer [45].

- *Attractive Platform for Users*

Several Studies indicate that, integrating IAs such as AR, VR, and MR in academic libraries are increase the number of users and make academic Library more Attractive. In fact, via IAs library users can learn, play, share, collaborate in an attractive environment [ref]. David King, Digital Services Manager, Topeka & Shawnee County Public Library say that "a lot of people they think of the library as the place to go to learn about emerging technology, [so] people will come to check out the new equipment maybe they can't afford, or they want to know or don't know what it is." [46].

5. Conclusion

IAs in academic libraries has become necessary and considered a new norm to enhance academic activity in research whether through traditional ways of research or if considering sharing research data through OS. For these activities to succeed, the academic library should recognize the challenges and opportunities of this type of technology before going through the process of implementation and adoption. Academic libraries need to establish policies, processes, and guidelines to promote IAs and OS usage in the academic institution and this would begin by recognizing the challenges and promoting its opportunities. This transformation may not be easily made. However, taking the first step would begin to change the whole academic environment and by understanding the users' needs from this technology.

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Section 2

Open Science

Chapter 3

Multiple Facets of Open: A Different View on Open Science

Anne-Katharina Weilenmann

Abstract

Open – a well-known word, but with multiple facets: open, open-minded... In the publishing industry, “open” and “openness” describe a movement which has been setting the scene over the last decades, however the opening of science is not a new momentum. Writing down our thoughts and ideas is regarded as a first indicator of opening the human mind. To cope with information overload, paper slips were used as a favourite device - a precursor to modern index cards and card catalogs. The internet opens the doors to disseminate and share knowledge in a fast and easy way. Now, science is emerging in cyberspace and an innovative level of science is shaping, the evolution of Cyberscience. Science is shifting into the open, Open Science is developing as an additional form of doing research. These diverse perspectives are part of a colorful picture of an evolving scientific landscape, which will rise awareness of changing work behaviors.

Keywords: Knowledge sharing, History of Open Science, History of Open Access, Open Data, Open Educational Resources (OER)

1. Introduction

Our world is a complex (eco)system, consisting of tiny structures, known and unknown secrets. Great creativity, genius ideas, surprising thoughts: these are only a few aspects of the creation of new knowledge, which allows to generate extraordinary findings and to disclose these secrets. It is a long and sophisticated process, sometimes an exhausting way to attain scientific and trusted results. Scientists carry a lot of responsibility, they are seen as experts„engaged entirely in a cognitive process, whose observation of phenomena and expertise in understanding what is observed leads to new knowledge." [1]. Observation of phenomena may be an important part of the whole scientific action and output; scientists may observe the entire environment and must have a critical view of the daily life. A lot of elements determine and influence the scientific process such as: thinking out of the box, curiosity, inspiration, the desire to investigate complex facts, great enthusiasm, staying power. Heinze focuses on scientific creativity and argues that essential elements of creative ideas and artifacts are usefulness and relevance [2].

1.1 The system of science

Each scientist has probably his own strategy to reach his goals. The aforementioned abstract expressions show the complexity of the scientific system and raise the question of how we can describe this. What does «science» mean, is there any definition for this umbrella term? Kuhn [3] states: "If science is the constellation of facts, theories, and methods collected in current texts, then scientists are the men who, successfully or not, have striven to contribute one or another element to that particular constellation." "At the same time, he doubts whether very much can depend upon a definition of «science» [3]. He highlights the diverse facets and broad meaning of «science», which is a difficult task, and shows its lack of transparency. The lack of transparency fosters the notion of the ivory tower where an elite works on scientific outputs, not interested in communicating these to society [4, 5]; the scientist is „the mad scientist reduced to a brain in a jar." [1].

To get out of this ivory tower, the scientific community has to demonstrate its experiments, developments, findings to a wider public, in a comprehensible form. Projects like PopSci [6, 7], the YES!-project [8], and initiatives enabling access to academic collections for laymen [9] are indicative of a better and clearer communication of science.

1.2 Citizen Science

Another approach is the engagement of society in scientific processes; this is the aim of «Citizen Science». Its origins go back to two different sources: on the one hand, research goals are determined by scientists and the public [10]; on the other hand, Bonney [11] refers to plenty of projects in avian research, in which citizens play an essential role as researchers. Hecker et al. [12] give a good overview of variations and distinct definitions concerning Citizen Science, especially mentioning the terminology set by governments and policymakers. They argue that participation serves as a basis for Citizen Science, that involving citizens in research is a key factor for this development. The whole process of creating new knowledge, from idea generation and planning to conducting the research and disseminating outputs, is now opened for all. Thus, Citizen Science is an integral aspect of the Open Access and Open Science movements.

Another viewpoint to consider is inclusivity in an open scientific landscape. The Association of College and Research Libraries (ACRL) outlines three elements to be addressed: people, content, and systems [13].

1.3 Open Science

The objectives of making science more visible and to communicate its findings fast and expediently open the door to a new movement, «Open Science». The driving factor of this initiative is openness to everyone. «Open» as a very broad expression illustrates the multiple connotations that go into this direction, but a formal definition of Open Science is lacking [14]. The Organisation for Economic Co-operation and Development (OECD) states that „... the term refers to efforts by researchers, governments, research funding agencies or the scientific community itself to make the primary outputs of publicly funded research results – publications and the research data – publicly accessible in digital format with no or minimal restriction as a means for accelerating research." [14].

Open Science is more than seamless access; Open Science is an attitude, a behavior; personal beliefs and values are predominant. But researchers face high barriers in their commitment to Open Science; neither using Social Media [15], nor sharing data [16, 17] to communicate latest findings are part of their daily working routines. Even early career researchers (ECRs) are reluctant to adopt new behaviors and to try Open Science tools [18].

Nielsen [19] sees Open Science not only as a «simple» movement, he speaks of a revolution, whereas Bartling et al. [20] argue that Open Science has the power to effect a profound metamorphosis and will change scientific communication and collaboration within the next 20 years more than has been done in the past 200 years (a detailed listing of different pillars of Open Science is explained in section 3).

2. Historical traces of Open Science

The difficulty to find a short and clear description of Open Science can be compared to that of tracing back the roots of this movement. There are many subtle indications of the presence of open knowledge. I will focus on some significant landmarks in the past which symbolize the current discourse of today.

2.1 Open Science – first signs

According to Borgman [21], the philosophy of Open Science goes back to Saint Augustine in the fourth and fifth centuries. Willinsky [22] and Stracke [23] see the beginnings of Open Science in the Middle Ages, referring to David [24] who analyses its history dating to the late sixteenth and early seventeenth centuries. If we take a closer look, we can dive deeper and go back to Antisthenes (444? BC, after 371 BC), a follower of Socrates (469 BC, 399 BC), who argued: „You would have done better to commit them to your mind than to your papers." [25]. The brain is a powerful instrument enabling us to store everything. The concept of memorizing by writing down essential thoughts leads to an underestimation of the brain - the brain would be «useless» if all of knowledge could be documented. This radical change can be seen as an initial evidence of openness: ideas are released from one's own closed mind and are opened up to everyone.

2.2 The Open Science revolution

As a consequence of this evolution, a scientific revolution is slightly shaping the future. Nielsen [19] describes the enthusiasm and eagerness of early discoverers to announce their innovations, but there was a little problem: how could they claim credit? Thus, for example, Galileo Galilei (1564 – 1642) had an unconventional plan: he sent his findings in the form of an anagram to the scientific community, so researchers were informed but did not know any details. Concerning openness, this means that scientists wished to spread their inventions, but at the same time they were reluctant to do so, because they were afraid of plagiarism. This behavior led to a new form of closure and indicated only a partial opening.

The vibrant time when Henry Oldenburg founded the world's first scientific journal in 1665, the Philosophical Transactions of the Royal Society, marks for Nielsen [19] the first Open Science revolution. Oldenburg asked scientists to disseminate their ground-breaking findings in a new medium, with the aim that communicating innovations would enhance and accelerate science [19]. But at the beginning, scientists did not trust this strange system and were suspicious to communicate and publish there.

2.3 From paper slips to the card catalog

Step by step, a specialized ecosystem was formed and a flourishing scientific community and networks were established, which became an efficient way to share new insights and discuss different results. This development contended with the task of how to organize and structure increasing amounts of information. In the early modern period, scientists used their own methods to confront information overload: they wrote their observations into commonplace books which consisted of bound manuscripts subdivided by headings; thus, news and topics had a fixed and permanent order [25, 26]. For the Swedish naturalist Carl Linnaeus (1707–1778), this strategy was not suitable. To best organize his system of plant classification, he took little paper slips of a standard size to sort all of the collected information about plants and animals; as the paper slips looked like modern index cards [26], this could be seen as a sign of a transition to the progressive card catalogue. With his paper slips, Linnaeus was able to work with a powerful instrument. Ordering the snippets in the correct form (alphabetically), allowed him to find the appropriate information, while at the same time he could make mistakes in arranging the cards [26]. Thus, the momentum of ordering could also be seen as an act of disordering; it enables and improves access to a vast amount of collected information, which again fosters an enhanced dissemination of knowledge.

The card catalog as device for the structuring and representation of knowledge offers, according to Krajewski [27], the possibility to preserve written text and to store it for the long term. As a logical continuation, he proposes to put this «genius apparatus» to an electronic level. The shift to the electronic/digital age gets the new paradigm and builds the next step on the way to openness.

2.4 Cyberscience

A great progress in this direction was the invention of the Internet with its nonlinear structure of hypertext [28]; it opened (and continues to open) the door to the discovery of endless content and has revealed (and continues to reveal) previously unknown topics. The progressive transformation from analog to digital science was shaping, which marks for Nentwich [29] a new scientific era, the beginning of cyberscience (the word «cyberscience» was coined and introduced by Nentwich [29] in the year 2003): „The point is that the new science is taking place in a new space, cyberspace, and not (only) in real places, which can be reached via telecommunication.» [29].

A new era, new technologies, new workflows; the scientific community is experimenting with amazing tools and is testing and exchanging many extraordinary experiences. The vanishing of reality and virtuality as unique places has led to the creation of one big room and should enhance science; however, this remains a big challenge for all stakeholders.

2.5 Cyberscience – a broad range of terms

The experimentation phase may be perhaps the reason why the terms and expressions concerning science in cyberspace are manifold.

Hey and Trefethen [30] use the expression «e-Science» to describe the digital developments, for O'Brien [31] «e-Research» is more appropriate, Borgman [21] defines it as «i-Science» and at the same time she distinguishes between «Open Scholarship» and «Open Science» [21].

In accordance with the shift from real spaces to virtual spaces, science becomes «Science 2.0», which indicates a new level of connectivity, and additionally «Science 3.0» is rising. Whereas Teif [32] with «Science 2.0» indicates and discusses the concerns of Open Access, especially the peer reviewing system, Basset et al. [33] refer to «Science 3.0» as a vague new system of open innovation and semantic search tools. Hoefler et al. [34] point to the difference between «Science 2.0» and «Open Science»; they see the aim of Open Science as opening up science, while Science 2.0 implicates the use of web 2.0 tools for science.

Another approach to underline the digital turn of science is represented with the notion of «Open-notebook Science», introduced by Bradley [35, 36]. He is not satisfied with the present system: when discovering new substances he would not publish these in journals, because he would not have the desired impact. Therefore, he started the blog «UsefulChem»; (the last post is dated from September 03, 2006), where he posts all the information written in paper notebooks. As he did not find an equivalent electronic tool that was open enough to communicate his findings, he collected his insights into a wiki, which is the beginning of the «Open-notebook Science».

Here it is not the process of doing science that determines the word «open», but rather it is its instrument. This may be a prompt to the integration of «open» in the daily working habits of scientists.

By placing the focus more and more on the philosophy of «open», the expression «Open Science» has gained wider acceptance. In the year 2014, the first international conference on the subject of science and openness, «Science 2.0», was held in Hamburg (Germany); now the conference is regularly held in Berlin, under the name «Open Science Conference» [37].

3. The pillars of Open Science

3.1 General aspects

As mentioned above, we will not find a standardized definition for the global movement of Open Science; a single definition is missing. In most cases, there are very vague descriptions, consisting of general formulations like «publicly accessible in digital format» [14].

A more concrete explanation is offered by «Open Definition» [38] which tries to define the meaning of «open» in the context of knowledge: «Knowledge is open if anyone is free to access, use, modify, and share it - subject, at most, to measures that preserve provenance and openness.» [38]. Furthermore «Open Definition» outlines two aspects that are of essential importance: «Open works», which has to fulfill the requirements of the open license, accessibility, machine readability and the open format; and «Open Licenses», which should be compatible with other open licenses [38]. A more distinct view is given by Fecher and Friesike [39] who consider five principles to introduce Open Science - the five basic «schools of thought». First, they propose the «infrastructure school», which relates to the technological aspects of Open Science; by «public school» they mean accessibility of knowledge creation; the «measurement school» implies the discourse concerning alternative impact; then there are the «democratic school» and the «pragmatic school», concerned respectively with access to knowledge and collaborative research [39]. With their study, Fecher and Friesike [39] point to the diverse directions and meanings, through which Open Science can be established; this is an essential basis to advance the notion of Open Science.

3.2 The different pillars of Open Science

Which components are needed to build and maintain a reliable Open Science system? How will Open Science look like in detail? Here again, we will see varied ideas and opinions to «design» a sustainable Open Science organism. Different approaches are proposed concentrating either on the infrastructure or on the workflows and tools.

In the year 2014, the European Grid Infrastructure (EGI) developed the vision of the Open Science Commons, consisting of four key pillars: data as the main basis of research, e-Infrastructures (future-driven technologies, connected services) scientific instruments (equipment and data centers) and knowledge [40]. As a leader in the Open Science movement, the University College London (UCL) presents a more sophisticated view on this and defines eight different pillars for an Open Science enhanced work [41]; these are the «FAIR Guiding Principles» (FAIR Data Principles: Findable, Accessible, Interoperable, Reusable Data [42], see section 3.2.3), research integrity, next generation metrics, while further important points are topics of tomorrow like the future of scholarly communication, Citizen Science, education and skills, rewards and initiatives, and the European Open Science Cloud (EOSC) - the ambitious project of the European Union.

Bosman and Kramer [43] provide a remarkable contribution. As they recognize that there is no general discourse on Open Science perceptions and definitions and that there are many irritating statements on this, they undertake an exhaustive review of terms and expressions, resulting in the proposal «Defining Open Science Definitions» and conclude with the following «six shades of open» [43]:

Open Source
Open Hardware
Open Access
Open Data
Open Educational Resources (OERs)
Open Science

Whereas Open Science is the umbrella term for the aforementioned five components, the purpose here is to point to these five parts, to raise the awareness for remarkable insights and to highlight outstanding papers; thus, to complete the big mosaic of Open Science and so to show the multi-faceted views on this topic.

3.2.1 Open Source, Open Hardware

The subject of Open Source and Open Hardware is as broad and multilayered as the history of Open Science.

«Free/Libre/Open Source Software, or FLOSS, describes both a philosophy of software freedom and a widely accepted set of best practices for the development of software by distributed communities, often made up of volunteers. The core philosophy of software freedom is that software should be free to use, study, copy, modify, and redistribute.» [44]. Going back to the roots, Richard Stallman initiates the General Public License (GNU) project in the year 1984 and establishes the Free Software Foundation a year later [22, 45]. An essential factor to support this new idea is to understand the backgrounds of «free software»: «'Free software' is a matter of liberty, not price» [22], in other words, creativity and freedom are the basis to use, reuse, change the code and share free software.

The main prerequisite for realizing Open Science projects is to work with Open Source Hardware and Open Source Software; perhaps, this may be regarded as a matter of course, but sometimes it is neglected. Some proposals on how this could be accomplished are offered, for instance, by Pearce [46].

The world of galleries, libraries, archives and museums (GLAM) can also benefit from Open Source Software; in these institutions almost every task can be fulfilled in this manner. Chudnov [44] shares some thoughts and suggestions to set up Open Source Software in libraries. Further instructions, literature and all stuff to stay up to date, can be found in the e-journal «The code4lib journal» [47], which was established in the year 2007 and is free to access.

3.2.2 Open Access

Probably the most common component of Open Science is the Open Access movement, often very enthusiastically and controversially discussed. Officially launched with the «Budapest Open Access Initiative» in 2002 [48], then followed by the «Bethesda Statement on Open Access Publishing» (2003) [49] and the «Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities» in the same year [50], the consensus on Open Access is, in a nutshell, that the content and software tools must be openly available and compatible [49].

These important initiatives and claims let us sometimes forget that there are a few essential cornerstones to mention which have influenced strongly this new challenge. In an illuminating synopsis of the prehistory of Open Access, Moore [51] debates and explains the highlights of a gradual opening. In 1971, Michael S. Hart founded "Project Gutenberg" [51] at a time when the Internet was in its early stage. The aim of this activity was and is to make electronic texts (Etexts) available in the simplest and easiest forms to use [52]. Whereas this ambitious plan was intended for a more general public, the scientific community was confronted with other challenges. Hence, Paul Ginsparg launched the arXiv preprint database (1991), an email/FTP server for high-energy physics research articles [51, 53]. The big potential of this server was the simplicity and promptness in being able to post and share the latest research findings. Prior to this, there was another extraordinary service that deserves a mention, perhaps it was only an experiment. In 1961, the National Institutes of Health (NIH) in the United States formed the Information Exchange Groups (IEGs); their task was to circulate biological preprints among the community, which became a great success [54]. Despite this success, the IEGs had to be abandoned in 1967, because journal publishers refused papers circulated as pre-prints. This was a brave attempt and at the same time a predecessor of today's pre-print servers.

The Open Access landscape exhibits a bright picture with different shades of color. Björk [55] has given an enlightening overview of this landscape. He describes the whole range: from green (manuscript self-archival), to gold (full Open Access, with article processing charges - APCs), to platinum Open Access (non-APC-charging gold Open Access) to black (illegal Open Access), to point in the end to rogue or Robin Hood Open Access, a term taken from Archambault [55] (rogue or Robin Hood Open Access is accessible for free, despite of restrictions, usage rights, or copyrights [56]).

We could consider these colors as a metaphor for the economic models of Open Access. In September 2018, the announcement of Plan S [57, 58] was like a disruptive shift; this proposal is to change the whole publishing industry. The scope of Plan S is that all funded European scientific papers have to be published in compliant Open Access journals or platforms and that they are immediately accessible by 2020, which is an enormous requirement. This topic is now permanently in the centre of attention, critical voices are heard and are not rare [59–61]. Plan S and its consequences are still in an experimental phase, we are yet to see whether this will lead to an acceptable foundation.

It might be advisable to take a look at the economic effects of Open Access and to shed light on several outstanding views. While Tennant et al. [62] and Fell [63] concentrate on the societal and economic impacts of Open Access or rather Open Science, Eger and Scheufen [64] see it in a broader perspective. In an international survey with more than 10,000 respondents from 25 countries, the authors conclude that

"... OA is more likely to be driven by the respondents' field of research than by their country of residence." [64] and that the gold road of Open Access (with publication fees) is the common model for publishers.

Besides this informative economic discourse, it was perhaps especially the spirit and the enthusiasm of the Internet pioneers and their developments which could be seen as early signals for a general opening (of minds); it is their unnoticed work which also merits appreciation.

3.2.3 Open Data

Data sharing is a conundrum [65], perhaps data are an obscure object of fascination. Borgman [65] describes research data as difficult to interpret; moreover, she states that they are available in many forms and are used in many ways. This variety indicates that science is data-intensive; it is imperative that there are reliable guidelines for dealing with research data and for coping with ethical issues.

The most important subjects to consider here are the «Panton Principles» [66] and the «FAIR Guiding Principles» [42, 67], to GO FAIR [68]. As one of the essential points to ensure a critical and appropriate handling of data when publishing it, Murray-Rust et al., the authors of the "Panton Principles", recommend the "explicit and robust statement" [66] of the author's own wishes in regards to how the data can be (re-)used. Once published, data must follow the «FAIR Guiding Principles» [67], formulated by an international group of researchers and other stakeholders. Data should be, to outline the key points:

Findable: data must contain rich metadata, (meta)data must have a unique and persistent identifier;

Accessible: (meta)data must be accessible, even when the data are no longer available;

Interoperable: (meta)data have to use a formal, accessible, shared, and applicable language;

Re-usable: data should have a clear and accessible data usage license.

In addition to the «FAIR Guiding Principles», The Global Indigenous Data Alliance launched the «CARE Principles for Indigenous Data Governance» [69]. While the FAIR initiative puts the focus on the characteristics of data, CARE is more people-oriented. It contains four key points and reads as follows [69]:

Collective Benefit: inclusive development, citizen engagement, equitable outcomes;

Authority to Control: rights and interests, data for governance;

Responsibility: for positive relationships, for expanding capability, for indigenous language and worldviews;

Ethics: for minimizing harm and maximizing benefit, for justice, for future use;

When implementing all of these principles the scientific community will «Be FAIR and CARE», (#BeFAIRandCARE) [70] and can act in a reliable manner.

Data – a «magical» and precious conundrum, may be a great challenge for researchers. Data sharing is not as easy as it seems; often, researchers do not see any need for it and are reluctant to share their data. Data sharing depends, too, on the researchers' mindset and personality.

The researchers' working methods and especially their sharing habits are heavily observed and under scrutiny by the Open Science community. Two fundamental studies examine the barriers for sharing and for not sharing data. Tenopir et al. [71] explore barriers and enablers of data sharing among 1329 scientists; their findings show that scientists are not willing to make their data electronically available and that this is often a question of culture. According to Borgman [65], there are four distinct reasons to consider when sharing data: to reproduce research, to make publicly funded research available to the public, to enable others to ask new questions, and to advance the state of research and innovation. She argues that the challenge will be to understand which data might be shared and to have a deeper look at the collaboration patterns of the networked community. In another international study, Severin et al. [72] investigate discipline-specific Open Access publishing practices. They observe great differences among the various subjects, and especially in the legal domain the commitment to Open Access publishing is rarely present.

Kim et al. [73] shed light on the attitudinal beliefs and social norms of scientists, whereas Linek et al. [74] undertake an informative study based on their personalities. The results of the latter study show that sharing habits strongly depend on personality traits (extraversion, neuroticism, openness, agreeableness and conscientiousness).

Finally, it is worth mentioning that all publishing related phases can be realized in the "open" (Open Peer reviewing, Open Methodology).

3.2.4 Open Educational Resources (OERs)

In the year 2001, the Massachusetts Institute of Technology (MIT) launched MIT OpenCourseWare (OCW) [75], a learning platform with all MIT course content, freely accessible. This was the inspiring moment for other future-oriented institutions to experiment with free learning materials. Massive open online courses (MOOCs) and online universities were established and were prosperous, but the hype has ceased.

These developments show the potential of open content, as a new media type was created, namely the Open Educational Resources (OERs). The characteristics of OERs are «teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use or re-purposing by others.» [76]. In the Open Education License Draft, Wiley [77] defines the "Four Rs of Open Content":

Reuse – Use the work verbatim, just exactly as you found it;

Rework – Alter or transform the work so that it better meets your needs;

Remix – Combine the (verbatim or altered) work with other works to better meet your needs;

Redistribute – Share the verbatim work, the reworked work, or the remixed work with others;

For teaching and learning institutions, OERs gain more and more relevance and are considered as a factor of success and a competitive advantage for universities. How do faculty adopt and implement OERs, how should or could faculty and libraries collaborate to promote and produce OERs?

The first findings in this matter reveal that faculty are open to and appreciate the traditional tasks of librarians (discovery, cataloging, information literacy), but they do not like receiving librarian support otherwise [78]. In an extensive study, Proudman et al. survey 146 European libraries of higher education on the topics of Open Education and OERs [79]. Eight aspects are investigated: the costs of education and Open Education; organization; Open Education Policy; library engagement and leadership; Open Education Advocacy; services; skills and challenges; and opportunities. The authors conclude that the greatest obstacles in supporting OERs are lack of funding and questions of culture.

OERs are a great driver for libraries and institutions of higher education; therefore, this topic should become a matter of course for all information professionals and library-related organizations.

3.3 Open Science consistently in mind

If we recognize the values and philosophy of the Open Science movement, in the final analysis this would mean that the full research process, from the beginning to the end, including the writing process, is documented, open, and transparent. Christian Heise has made an audacious attempt in describing the difficult phases of writing his doctoral thesis as an Open Science project [80]. Apart from the fact that it is the «first completely open humanities-based PhD thesis» [81], the result indicates that Open Access to the content is only the first step, and that additional smaller and bigger efforts are required for the opening of science.

3.4 Skills and expertise

A well-structured Open Science system is an important precondition for the promotion of Open Science and for supporting its aims. What does this mean for researchers? Are they now working in another connected environment, in an open-minded context? Do they need further skills to fulfill their tasks?

In a report, the Working Group on Education and Skills under Open Science [82] analyses the most indispensable competencies for researchers on the way to openness. These competencies are divided into four categories: knowledge concerning Open Access publishing, knowledge regarding research data and data production, a close connection to the researcher's own scholarly and disciplinary community, and supporting citizen science.

With FOSTER, a training platform for the research community was created, covering all aspects concerning Open Science, with detailed learning materials and guidelines [83]. A special feature of this platform contains the vast terminology related to Open Science [84]. The European Commission released the report «Digital skills for FAIR and Open Science» [85], to shed light on these two evolving topics, to strengthen their importance and interaction. The aim of this report is to develop the next generation of «FAIR and open science professionals» [85] within the European Open Science Cloud (EOSC) [86]. In a detailed description, ten roles of envisioned Open Science professionals are defined (researcher, EOSC enabler, data scientist/data analyst, research software engineer, data research infrastructure support professional, EOSC educator, data curator, data steward/data librarian, citizens, policy maker). The future plan is to compile a catalogue of learning and training resources.

These skills might be very important; however, workflows and processes in the Open Science era do not require more specific knowledge. It is essential to be up-to-date and to be aware of 21st century technologies and new tools, to use them and integrate them into daily routines. A substantial factor will be to open up one's own "knowledge treasure" and to share valuable insights while working in the openness.

4. Vision «Open Space»

To go back to the roots of «open», showing the multi-faceted meanings of this term, enables to draw a fine-grained picture, a picture which is not yet completed, with parts which can and must be changed and expanded to represent the dynamic status of research and innovation.

Disruptive technologies and digital transformation are key drivers of change in our social system. This has great implications for further and higher education and on the working behaviors of scientists (and all other researchers). Universities worldwide are under great pressure to adopt new forms of teaching and learning.

The campus as physical space serves no longer as the main area to meet and learn and is shifting to virtuality; virtual and physical spaces are merging [87]. The annually published trend scouting study «Horizon Report Trends» [88] scans technological developments and serves as a leading instrument of prospective tendencies in higher education. It gives an overview of trends to implement in the near future, categorizing them into five parts: social, technological, economic, political trends, trends in higher education. Procter et al. [89] describe research as «Research 4.0» and discuss the influence of Artificial Intelligence on academic research methods concerning the UK research landscape (but it also points to general transformations and changes).

How could these challenges determine the movement of «open» and the shift to a new perception of research, learning, and teaching? What does the future of Open Science look like, how could we build and develop an Open Science environment to best meet the requirements of researchers?

Openness does not depend on virtual or physical spaces; Openness means collaboration, sharing, using free tools, Open Access to scientific literature, to mention only a few points. Ayris et al. [90] and Ignat et al. [91] suggest to embed libraries in the Open Science landscape from a European perspective. Whereas they refer to the institutional level, I would focus here more on the researchers' view and imagine the vision of «Open Space».

«Open Space» is designed as an open research platform, which is seamlessly integrated into the whole Research Life Cycle [92], containing three phases: «before research», «during research» and «after research». When researchers begin their work, they are automatically connected to «Open Space» (the authentication procedure is done at the beginning of a new project), where they can meet the international research community of their discipline (as well as other disciplines) to search for collaborators. The process of finding other researchers is facilitated by the Current Research Information System (CRIS) of each university [93, 94], which is embedded in the "Open Space" platform. The CRIS offers a topical overview of the institutions' research output, documenting not only scientific publications, but also research projects, lectures, prices [94]. In this innovative environment, they can use the available toolbox, which contains important materials for the research process (e.g. for collecting data, reading and writing). The «Open Space» platform can be personalized (searching patterns, recommendations…); additionally, researchers will find an advice button for 24/7 consultation with the Open Science library division and guidance with the working processes. «Open Space» will be an open and scalable ecosystem, where all stakeholders are interconnected to build and expand a sustainable research infrastructure for a meaningful future. Such an «Open Space» platform would foster and encourage the creation of the «Openness Profile» [95], an initiative of Knowledge Exchange (KE) [96], "to enable open research practitioners to compile a diverse range of contributions and make those contributions accessible in order to get credit for them." [95]. The final version of this report [97], published in March 2021, puts the focus on the evaluation and recognition of publications to Open Scholarship practice. This scenario is a first input and could serve as inspiration; the design of a sophisticated platform has to be considered/examined well and can take months.

Finally, we should ask the question to what extent openness could go, how «open» such a system should be. Is there an unlimited openness? If we go back to envision the beginnings of the movement, the early adopters who opened their minds to taking notes of their inspirations (see sections 2.1, 2.2), then we could imagine a similar scenario in a new technological era, our brain connected to the computer: "Interface University would be based on the idea that machines cannot fully supplant human cognition and that thinking with machines allows students to engage in a level of cognition not possible with the brain alone." [98]. Might be, that these are perhaps thought-provoking ideas, but recognizing outstanding developments is an important pre-condition for creating future learning and research spaces.

5. Conclusion

The movement of «open» has a long and fascinating history, and to trace it back and unveil its origins is a complex task. The first steps of opening one's mind, communicating and sharing new thoughts, writing down unknown ideas on cards, and reaching a new level of openness and inter-connectedness with the Internet, show a slight shift from closeness to openness, but we have a rather long way to go: «'Open research' is a useful shorthand for the sort of open research practices that are thought to help to speed the pace of discovery – but it is far from a concrete concept and must be reified anew depending on the particularities of the research and the changing affordances of the wider technological, scholarly, and cultural environment.» [99].

Knowing the past means to raise awareness of future trends, to facilitate the work on concrete projects, to recognize little changes and hidden signs, and could thereby contribute to fostering the openness of science in a dynamic scientific landscape.

Conflict of interest

The author declares no conflict of interest.

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Section 3

Open Access

Chapter 4

Overview of the Principles and Practices of Open Access Publishing

Omer Hassan Abdelrahman

Abstract

This chapter provides an overview of the principles and practices of open access (OA) publishing. It discusses various aspects of this emerging mode of scholarly publishing, including the definition of Open Access and its different types and models in addition to its growth and impact. The chapter also highlights the implications of open access publishing on copyright issues and how creative commons licenses are used to deal with this issue. The main focus of the chapter is to outline and discuss the different advantages and benefits of open access publishing, refuting a number of myths and misconceptions about OA publishing, and to highlight how authors and researchers can benefit from publishing their intellectual works in an open access channel. The chapter adopts the literature review as a methodology and a tool of data collection.

Keywords: open access publishing, types of open access publishing, open access and copyright, creative commons licenses, benefits of open access publishing

1. Introduction

Proprietary or "paywall" publishing mode dominated the scholarly world throughout the late 20th and early 21st centuries. This is for-profit commercial publishing where publishers make their returns by the collection of research of scholars, application of peer-review, offering of editorial and formatting services, the collation of this research into subject-specific journals, and then selling subscription-based access of these works to academic libraries, scholarly societies and individual researchers. Access to individual articles on a short-term basis (typically 24 hours) is also supplied on a pay-for-use model. Commercial publishers also provide publishing facilities for books and monographs, although these have been on the decline [1]. The advent and wide use of the internet have strongly affected the process of scholarly publishing worldwide. A new mode of publication has emerged and widely employed by scholars and researchers. This new mode is Open Access (OA) publishing of scholarly work. This chapter will discuss OA focusing on its benefits to all the stakeholders and presenting other aspects of this new way of scholarly communication including its definition, types, development, its pros and cons and the myths and misconceptions surrounding it.

2. Definition and types of open access

2.1 Definition

Open access refers to free, unrestricted online access to research outputs such as journal articles and books. OA content is open to all, with no access fees. Open access is more than free access. When people think about open access (OA), they immediately relate it with free access. Providing reuse rights is another important asset of open access. Open access in its purest form is "digital, online, free of charge, and free of most copyright and licensing restrictions". Open access entails a new model of publishing wherein the author, supported by an institution or funding agency, pays the publishing costs and owns the copyright. The publisher manages the peer review process and publishes directly to the Internet, where content is accessible free of charge to the public. Open access publishers take full advantage of available computing technology to streamline the publishing process [2]. Open Access aims to provide users with information that is unconstrained by the motive of financial gain or profits [3]. Furthermore, Open access implies that "users must be able to copy, use, distribute, transmit and display the work publicly and to make and distribute derivative works, in any digital medium for any responsible purpose, subject to proper attribution of authorship" [4, 5].

In subscription-based publishing, authors are required to transfer the copyright of their works to the publisher who makes profits via the dissemination and reproduction of the works. Contrary to this, with OA publishing, authors can retain copyright to their work and license its reproduction to the publisher. The most commons licenses used in open access publishing are the Creative Commons (CC) licenses. The widely used Creative Commons By Attribution (CC BY) license is one of the most permissive, only requiring attribution to be allowed to use the material (and allowing derivations and commercial use). A range of more restrictive creative commons licenses are also used. More rarely, some of the smaller academic journals use custom open access licenses. Some publishers (e.g. Elsevier) use "author nominal copyright" for OA articles, where the author retains copyright in name only and all rights are transferred to the publisher [6].

2.2 Brief background of the development of the OA movement

The OA movement can be said to have started in the year 1971 with Project Gutenburg Founded by Michael Hart [7]. This project is now providing free public domain text files with more than 60,000 eBooks. However, the modern open access movement began in the 1990s with the wide availability and access to the World Wide Web and online publishing became the norm. Starting in the early years of the 21st century there was a significant momentum towards making access to published research free of charge to scholars and universities through the Open Access movement. Three pioneering initiatives laid the foundation for the ideas and principles of OA movement. These are The Budapest Open Access Initiative on Feb. 14, 2002, The Bethesda Statement on Open Access Publishing on Apr. 11, 2003, and The Berlin Declaration on Open Access on Oct. 22, 2002 [8]. The Budapest Open Access Initiative was worked out during the human rights proponents gathering for the Open Society Institute meeting in December 2001. During the meetings a number of participants suggested that a global support is needed to create open information access within the scientific community. A draft was created during that meeting, and formalized two months later, in February 2002 as the Budapest Initiative. In April 2003, the United States and the United Kingdom based biomedical community convened and drafted a set of publishing principles guiding scientific dissemination. These principles were finalized and published in June 2003 as the Bethesda Statement. In October 2003, the European scientific community called for support by European researchers to engage in Open Access, with the Berlin Declaration [9].

Many stakeholders contributed to building institutions and resources for shaping up the global OA movements. Some of the institutions emerged during the first two decades of the third millennium are namely, Public Library of Science (PLOS), BioMed Central (BMC) – publishers of peer-reviewed OA journals, the Scholarly Publishing and Academic Resources Coalition (SPARC), and Open Access Scholarly Publishers Association (OASPA) [10]. In addition to the previously mentioned (BBB); the Budapest, Berlin and Bethesda OA declarations or statements got signed by the scholarly communities, particularly by the funding agencies, research councils, learned societies, institutions, universities, and scientists for the OA dissemination of public funded research.

The latest strong support for the OA movement is represented by what is known as PLAN S where the s could stand for "science, or shock" but "speed" is the most relevant where it refers to speed with the transition to direct and open access [11]. Plan S is an initiative for Open Access publishing that was launched in September 2018. The plan is supported by cOAlition S, an international consortium of research funders. Plan S requires that, from 2021, scientific publications that result from research funded by public grants must be published in compliance with Open Access journals or platforms.

2.3 Types of open access

There are three basic types of open access publishing. These are Green Open Access, Gold Open Access, and Hybrid Open Access [12].

2.3.1 Green open access

Green Open access publishing refers to the self-archiving of published or pre-publication works for free public use. Authors provide access to preprints or post-prints of their works with publisher permission in an institutional or disciplinary digital repository. Thus, Green open access refers to the practice of republishing a publication in an open access institutional or disciplinary repository. In this case the publication is first published in a traditional, closed-access journal. These materials are then made available to all via the internet, without restrictions or pay walls. In the "Green Route" of open access, institutions create repositories for their own research which is made open after an appropriate embargo period agreed upon with commercial publishers. As such Green Open Access generally refers to the post-print of an article [1]. In this context, there are three basic version types that can be self-archived in repositories: These are:

- Pre-Prints – The author's copy of article before it has been reviewed by the publisher, or pre-reviewed.

- Post-Prints – The author's copy of article after it has been reviewed and corrected, but before the publisher has formatted it for publication, or post-reviewed.

- Publisher's Version – The version that is formatted and appears in print or online.

2.3.2 Gold open access

Gold open access publishing refers to works published in an open access journal and accessed via the journal or publisher's website. The Gold Route involves publishing in an open access journal, which then provides the dissemination and curation services in the same way as current proprietary publishers. This form of publishing is funded through government, society or institutional grants, and sometimes through charging authors a fee for deposit, known as an article processing charge (APC). However, the latter practice is implemented by a minority of open access journals and most journals do not charge any fees at all [13].

2.3.3 Hybrid open access

Hybrid open access publishing is mostly associated with gold open access. It takes place in journals that offer authors the option of making their articles open access, for a fee. Hybrid journals are subscription-based journals that make individual articles openly available in return for a fee. The hybrid route has been suggested as a means for traditional publishers to make a transition to open access publishing without significantly decreasing revenue, by charging fees for open access articles equal to the average subscription revenue per article. In the Hybrid Open Access publishing type, sometimes called Paid Open Access, the fee is paid to the publisher or journal by the author, the author's organization, or the research funder [14, 15].

There are a number of other variations of these major types of open access publishing types. These include the Diamond Open access and the Platinum Open Access. The Diamond Open access journals provide scholarly publishing free of fees and access charges. They have direct or indirect subsidies from institutions like universities, research centres, government agencies etc. Whereas the Platinum model of open access publishing refers to the situation in which journals are published directly by the research or funding institutions themselves.

In Gold and Hybrid OA models, publishers usually publish articles with Creative Commons (CC) licenses. Open Access does not imply there is no copyright attached to the open document; rather, in most cases the Creative Commons Attribution License (CCAL) model is used. Founded in 2001, the CCAL states that users are free to share, adapt, or use the work as long as they give attribution in the manner specified by the author or licensor [16]. The Attribution License is one of six codes under the Creative Commons License. Thus Open Access journals do not charge subscription or pay-per-view fees compared to traditional journals. The authors, their institutions, or the research funders pay the "open access" fee to make it free to readers; authors retain copyright for the article and most permission barriers are removed [17, 18].

There is a controversial type of open access called the Bronze Open Access. In the Bronze model no open access Fee is paid but the publisher chooses to make a publication freely available to read. Many Open Access advocates and research funders would not regard Bronze as truly Open Access because the publisher can stop the publications being freely available at any time, whereas genuinely Open Access publications have a specific licence that means the publication is irrevocably open access and the terms of use and reuse are clearly stated [19].

Although bronze OA lacks a license, it is temporarily free to read only on the publisher's website, and Publishers can deny access to the majority of open-access articles at their discretion [20].

2.3.4 Gratis vs. libre open access

These two terms are interlinked to the basic three types of open access. But in contrast to Gold, Green and Hybrid OA, they do not describe forms of publication, but define the attributes of an article published in OA. Therefore an article might be described jointly as Gratis Open Access, or Gratis Gold or Green Open Access, etc. [21]. Gratis Open Access means free of charge Open Access. This means that price barriers alone are removed from access to the publication. It allows no uses beyond what is considered legitimate under copyright and fair use. Libre Open Access, on the other hand, means free of charge and free of at least some permission barriers. This means that the article is free for some kinds of further use and reuse, and presupposes some kind of open licence that allows types of uses that are not permitted by default [22].

3. Advantages and disadvantages of open access publishing

3.1 Advantages and benefits

Open access publishing has a plethora of advantages for authors, institutions and readers across all sections of society. These advantages can be summarised as follows [8, 23]:

i. Increased accessibility of research work by users and other researchers. This leads to the enhancement and acceleration of the research cycle when results are available on an Open Access basis, where work is published, read, cited and then built upon by other researchers.

ii. Increased visibility for authors and institutions, resulting in a higher impact of the research. There are no financial or copyright barriers so the readership continues to increase, enhancing the visibility and impact of the author's Work. There is a greater chance of research results being seen when scientific journals are free to read and use, thus influencing the thinking of others. This state of affairs results in the increase of the academic's impact factor.

iii. Immediacy and Shorter publication times compared to non-open access publishing. Open access publishing takes shorter period of time from the date of submission of an article to a journal to its publication date.

iv. Increased citations. A number of studies revealed that open access publishing leads to a greater number of citations. There is accumulating evidence showing that open access research articles are cited more often than those closed access articles. The studies reveal that across most subject areas there is at least a twofold increase in citation rate and that in some subject areas it is even higher [24].

v. Removing of price barriers. Open access removes price barriers and that openly accessible works are often full-text indexed, helping potential readers easily locate a work using a search engine, and access the work without being turned away by pay walls.

vi. Contribution to author royalties. Some authors found that widespread dissemination of their openly accessible works stimulates demand for print copies of their works, contributing to royalties for these authors [23].

Those seeking wider visibility of their research work, higher impact for their research, less publication cost, and a shorter period of time from the date of submission to the publication date, should opt for publication in an OA journal [25].

3.2 Disadvantages

The most prominent and prevalent disadvantage of OA publishing is the emergence of predatory publishers and predatory journals. A predatory journal will not maintain the academic standards that are expected of a reputable scientific journal. The objective of the predatory journal is to make money for the owners without concern for the quality of the research published. A predatory journal will pretend to follow the essential editorial processes required for authentic academic publishing, but will not so do. Thus the quality of the research published in a predatory journal is likely to be low. Predatory journals can be identified by a number of characteristics, the most important of which may be the fact that they tend to market themselves through intensive e-mailing to invite selective victims who might otherwise have difficulty in having their research published in reputable journals. This lead to the development of what has become known as the predatory journal, which for a fee paid by the author delivers an un-scrutinised and unedited piece of writing purporting to be a high quality report on a piece of rigorously conducted scientific research. These journals are then presented to the public as Open Access journals [8, 26, 27].

Another claimed disadvantage of Open Access publishing is that some OA journals do not have high impact factors and this is considered detrimental to a researcher, though this is questionable as many OA journals are new and have not yet received their first impact factor (IF). However, high-IF OA journals are available in a variety of fields [25].

4. Myths and misconceptions about OA

There are a number of myths and misconceptions surrounding open access publishing mode. Some of the most common myths include the following:

i. Myth 1: "open access journals are not peer reviewed".

ii. Myth 2: "all open journals charge publication fees".

iii. Myth 3: "authors must choose between prestigious publication and Open Access publication".

iv. Myth 4: "post-print archiving violates copyright".

v. Myth 5: "OA invites plagiarism."

vi. Myth 6: "OA helps readers but not authors."

vii. Myth 7: "All OA is gratis OA."

Below is a discussion of these myth and misconceptions about open access publishing with points that help dispel them.

4.1 Myth 1: "open access journals are not peer reviewed"

Studies show that the majority of OA journals are peer-reviewed with the same or higher standards as traditional scholarly journals. However, it takes time for a new OA journal to build a high impact factor [18, 28]. Indexing of a journal in a major citation database is also considered a reflection of a journal's quality. Indexing newly established OA journals in major citation databases is complex and time-consuming, furthering existing misconceptions of quality [8]. This myth entails that Open access journals are intrinsically low in quality. But as early as 2004, it was found that in every field of the sciences there was at least one open access title that ranked at or near the top of its field in citation impact. It's quite normal that open access journals can be of high quality and first-rate: the quality of a scholarly journal depends on its authors, editors, and referees, not its business model or access policy [29, 30].

4.2 Myth 2: "all open journals charge publication fees"

There are a number of OA journal business models and a number of OA book business models available. The models include the following options and variations:

- *Author-Pays model*, author pays publishing fee.
- *Research funder subsidies*, funding organisations pay author fees.
- *Institutional membership*, author fees are paid as a lump sum.
- *Publishing support funds*, institutions reserve funds for author fees.
- *Hybrid business model*, journals mix subscription based and author pays content.
- *Community-fee model*, societies fund journals by both subscriptions and membership fees.
- *Institutional subsidies*, institutions support their own university presses.

Charging publication fees in the form of author fees or article processing charges is the best-known business model for open access journals, but it is not the most common. Most peer-reviewed open access journals nowadays charge no fees at all. The Directory of Open Access Journals (DOAJ) [31] provides information about open access journals that do and do not charge fees. It is also well known that most conventional or non-open access journals do charge author-side fees, on top of reader-side subscription fees.

4.3 Myth 3: "Authors must choose between prestigious publication and Open Access publication"

OA is compatible with prestige for two reasons: First, a growing number of OA journals have already earned high levels of prestige, and others are earning it. The second reason is that most pay wall (Toll Access) journals allow OA archiving. When authors retain the right to self-archive, all journals willing to publish their work also allow self-archiving. The current misunderstanding has some negative effects. When scholars know about OA and don't choose it, they are generally not opposed to it; many support it strongly. They are simply giving higher priority to prestige. But because OA is compatible with prestige, authors rarely have to choose. But they have to choose only when a prestigious journal doesn't already permit post print archiving and when it rejects the authors' individualized request for permission. Authors rarely have to choose between them, but to have both at once they will often have to choose to self-archive [32].

4.4 Myth 4: "post-print archiving violates copyright"

Most publishers allow their authors to self-archive their articles in institutional repositories or on their own personal websites. However, conditions and restrictions are frequently imposed. For example, authors are often obliged to observe an embargo period between the publication date and the date on which the document is made openly accessible online. The SHERPA/Romeo Listings provide information on the self-archiving policies of individual publishers. They used to classify publishers in different colours depending on their archiving policies; green publishers let authors archive preprint and post print or publisher's version/PDF, blue publishers let authors archive post print or publisher's version/PDF, yellow publishers let authors archive preprint, and white publishers do not formally support archiving. But they recently stated that they have now retired the Romeo colours, as open access policies have become more complicated and the colours no longer gave a clear overview [33]. Many of those authors, whose publishers do not allow self-archiving, supplement their standard publishing agreements with contract addenda which enable them to provide open access to their work in parallel with publication [34].

4.5 Myth 5: "OA invites plagiarism"

In the early days of the OA movement some authors worried that OA would increase the incentive to plagiarize their work. On the contrary, OA might make plagiarism easier to commit, for people trolling for text to cut and paste. But for the same reason, OA makes plagiarism more risky to commit. Plagiarism from OA sources is the easiest kind to detect. Some of the misunderstanding here may arise from confusing plagiarism and copyright infringement. Plagiarism and infringement are two separate things although they are overlapping offenses. "Someone can commit plagiarism without infringing copyright (by copying a fair-use excerpt and claiming it as one's own) and infringe copyright without committing plagiarism (by copying a larger excerpt but with attribution). One can also commit both together (by copying a large excerpt and claiming it as one's own)" [32].

4.6 Myth 6: "OA helps readers but not authors"

OA articles are accessible to everyone with an internet connection, a vastly larger audience than any scholarly journal can claim. Not all internet users will care to read your research, of course. But making your work universally accessible to the connected guarantees that it will be accessible to the subset which does care. If there's an exception for the digital divide, there's a larger exception for the non-digital or print divide. Moreover, there's abundant evidence that OA articles are cited more often than non-OA articles, even more than non-OA articles from the same issues of the same journals [35, 36]. Many different studies have tackled this phenomenon, taking on different bodies of literature, using different methods, controlling different variables. They disagree on whether the OA impact advantage is large or small, and whether OA causes the increase in citations or is merely correlated with it. But they agree that OA articles are cited more often than non-OA articles. Authors may hope to earn royalties from their books, but they write journal articles for impact, not for money [37].

4.7 Myth 7: "All OA is gratis OA"

Gratis OA removes price barriers but not permission barriers. It makes content free of charge but not free of copyright or licensing restrictions. It gives users no more reuse rights than they already have through fair use or the local equivalent. Libre OA removes price barriers and at least some permission barriers. It loosens copyright and licensing restrictions and permits at least some uses beyond fair use [38]. There is some excuse for the opposite view, that all OA is libre OA. The Budapest, Bethesda, and Berlin definitions of OA all describe forms of libre OA. The current misunderstanding accepts that gratis OA is a kind of OA, but goes one step too far and assumes that gratis OA is the only kind of OA. The misunderstanding is that there is no libre OA, that libre OA adds nothing to gratis OA, or that what libre OA adds isn't necessary or desirable. In general, OA repositories have good reasons to stick to gratis OA but OA journals don't. Repositories can't generate the needed permissions on their own, but journals can [37].

5. Future of open access

5.1 Prevalence of open access

A large-scale study that investigates the prevalence and impact of OA publishing found that almost half of the scholarly papers that people attempt to access online are now freely and legally available [39]. The study tracked 100,000 online requests for journal papers in 2017. It examined reader data from a web-browser extension called *Unpaywall* which finds free-to-read versions of pay-walled papers in the Internet. The study authors analysed server logs of 100,000 papers that Unpaywall users tried to access during one week, and found that 47% of accessed studies were legally available to read for free somewhere on the web, and that around half the content being accessed was published in the previous two years. Their study also revealed that more than 20% of scholarly articles searched for through *Unpaywall* were available directly from journals, with clear licences describing whether the papers were free not just to read, but also to download or redistribute. Another 9% of the papers were still published behind a pay-wall, but authors later uploaded their paper to an online repository. The most intriguing category of papers was the 15% that were posted on a publisher's site as free to read, but without any explicit open licence. The authors say this type of open-access — which they call 'bronze', in contrast to the widely used 'gold' and 'green' definitions — has been scarcely discussed. Of papers published in the most recent year examined –2015- 45% were freely available, which suggests that newer articles are more likely to be open. The authors of the study concluded that the percentage of literature that is OA continues to grow steadily, and that "In the next few decades, we're going to be seeing nearly all the literature available freely." [39].

5.2 Plan S and the future of open access

Plan S is the latest initiative to promote and support open access publishing. Below is an excerpt from the Coalition website [40] which is the body responsible for the Plan S, revealing the target of this open access plan:

> *With effect from 2021, all scholarly publications on the results from research funded by public or private grants provided by national, regional and international research councils and funding bodies, must be published in Open Access Journals, on Open Access Platforms, or made immediately available through Open Access Repositories without embargo [41].*

6. Conclusion

This chapter presented an overview of the basic principles and common practices of open access publishing as an emerging and expanding mode of scholarly publishing. The chapter started with an introduction to the concept of open access publishing with a brief background of the development of the open access movement. The different types of open access publishing are then highlighted and defined. These types include Gold Open Access, Green Open Access, and Hybrid Open Access, in addition to other variations of these basic types namely, the Diamond Open Access and the Platinum Open Access. The concepts of Gratis vs. Libre Open Access are also defined and explained. The chapter then discussed the advantages and disadvantages of open access focusing on the various advantages of this mode of scholarly publishing to authors and readers as well. The chapter then proceeded to discuss and refute the most common myths and misconceptions about open access publishing. The chapter is concluded with some views on the prevalence and future of open access publishing.

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Chapter 5

Origins and Developments of the Open Access Books

Andrea Capaccioni

Abstract

The open access books (OAB) are a product of the research that in recent years has gained its place in scientific publishing and open access (OA). Both have gone from initial diffidence (for different reasons) to a growing interest. In the first part of the article, we present the most recent data relating to this kind of publication while in the second one the OAB phenomenon is examined within a more general evolution of the OA. In this way there seems to be a link between the open access monographs and the diffusion of models increasingly distant from the original mission of the OA.

Keywords: open access books, open access monographs, open access, scientific publishing, scientific communications

1. Introduction

1.1 At the beginning

The idea of the book accessible online for free did not originate in the academic world. Michael Hart (1947–2011), a computer scientist, is among the first to propose an initiative in 1971 called Project Gutenberg (PG, http://www.gutenberg.org/) [1, 2]. The PG's aim is making literary works in the public domain available on the web, not for profit [3]. The first etext was the United States Declaration of Independence, edited by Hart himself, and then in the following years Alice in Wonderland, some of Shakespeare's works, the Bible and other works. At the beginning, the growth in the number of electronic books was slow. Hart noted that in 1991 only 18 "eText/eBook" could be found online [4]. However, the time was ripe for a change and within a couple of decades, also thanks to the advent of the Internet, the number of online books began to increase significantly [5]. This new phenomenon has aroused the interest of the American publishing world and in particular of the university presses, which were engaged in tackling the relaunch of the scientific book which in those years was experiencing a moment of crisis. A first important initiative was taken in 1994 by MIT Press which made available through its website a free HTML copy of William J. Mitchell's essay, *City of Bits. Space, place, and the Infobahn*, simultaneously putting the paper edition on sale through traditional channels [6]. The experimentation, forerunner of the so-called "hybrid" model still widespread today, had given interesting indications: despite the availability of the free online copy, the printed edition had managed to sell 10,000 copies. In the mid-nineties of the last century, another American publishing house The National Academies Press (NAP) also offered some essays in electronic format for free and later other publishers, such as the Australian National University Press, followed suit.

The need to solve the problems linked to the dissemination of the scientific book convinced university publishers to seek new solutions. Already in 1994, the director of the National Academies Press Scott Lubeck understood that the network, at that time in its nascent state, could be transformed into an important propaganda tool for the publishing house's activities and for the relaunch of monographs [7]. The initiatives promoted in this phase inspired other attempts, but for a few years they remained limited to a small (also from a geographical point of view) circle of academic publishers. The times were not yet ripe.

We have to wait until the first decade of this century to hear about free e-books again. The best-known initiative was proposed by Google which in 2004 launched the Google Print initiative, an online collection of digitized volumes, some of which can be downloaded for free. The Californian company later decided to change the name of the initiative to Google Books and to characterize the project in a more commercial way, transforming it partly into a platform aimed at publishers interested in greater online visibility and in part into a large bookshop virtual dedicated to readers (Google Play). In this period, the term open access books (books OA) began to spread, as we will see presently.

2. Books become "open"

In those same years, the open access movement was also growing [8]. The story is well-known: supporters of the OA had taken a critical view of some large international publishers accused of jeopardizing access to scientific literature. The OA movement's interest has been concentrated on the very beginning on scientific journals [9]. It is enough to examine the founding documents to realize that there are no references to the monographs. The Budapest Manifesto (2001) refers only to scientific articles, in the Bethesda Statement (2003) we find a general indication relating to the publishing industry ("OA publishing"), but the reference to periodical publications continues to prevail, the Berlin Declaration (2003) contains the following words: "Contributions include original scientific research results", an expression that can also include books which, however, are not explicitly mentioned [10–12]. The reason for this preference is clear: the majority of researchers who write articles do not receive royalties, therefore they can be more available to open access. The authors of scientific monographs, on the other hand, are entitled to the compensation deriving from the sales of the works. The OA dissemination of their publications could deprive them of the compensation. This contrasts with the OA principles that take into account of researchers' rights. In recent years, however, the open access books, also known as open access monographs (OAM), have conquered an ever wider space within the open access movement and the scientific publishing. On the use of the different expressions, see [13, 14].

The growing presence of open access books in the world of digital libraries makes it possible to enrich the offer of academic research products available in OA, thus favoring a more active presence in the field of Open Science of many scholars, especially in the Humanities and Social Sciences (HSS). In this area, as is known, researchers make greater use of monographs as a scientific communication tool.

3. A growing reality

At first, both OA supporters and publishers were a little wary, for various reasons, of OA books (OAB). The change became evident from the present century when some publishers began to consider open access (OA), also thanks to the support actions of public and private institutions, no longer as a threat but as an opportunity [15].

The purpose of this part is to examine the OAB's growth in relation to the evolution of OA. The OA book, more precisely, began to take its first steps at the end of the first decade of this century and today it is a growing phenomenon [16, 17]. Simba Information, an American media and publishing consultancy, expects a 30% annual increase in open access books production until 2020 [18]. The information that can be obtained from DOAB, the online directory that collects updated data on open access books published worldwide, confirm this trend: during 2017 there were about 8500 OA books (or book chapters) published by 224 publishers, in February 2018 the number of the first ones had risen at 10853 and that of publishers at 254; in July 2020 there was a further increase with 29,422 academic peer-reviewed books from 389 publishers [5, 19, 20]. DOAB listed 2099 OA books published in 2018 with an increase of 38% from 2017 [21]. The data provided by AAUP (Association of American University Presses, www.aaupnet.org) also indicate a growth, although not linear: if we compare the survey reports Digital book publishing in the AAUP community of 2012 and 2017 we note that the publishers engaged in the publication of "online full-text open access" and "OA Content" went from 25 to 38, or from 31–61% of the total [22]. Numbers of the "fiscal year" 2016 "showed that 76% of presses received less than 15% of their book revenues from ebooks. Reported FY2018 show that 40% of presses are now receiving more than 15% of their book revenue from ebook format sales or licenses" [23]. In Spain, the percentage of publishing houses that published OA monographs went from 28% in 2016 to 59% in 2017 [24]. According to Simba information, there will be greater collaboration between publishers and institutions in the OAB sector in the coming years. An example is PEERE (http://www.peere.org/) a European Commission funded initiative that brings together various institutions belonging to the academic world and publishers such as Springer Nature, Elsevier and Wiley (and others) united in an effort to improve the quality and sustainability of peer review practices. Also, noteworthy is the HIRMEOS project (High Integration of Research Monographs in the European Open Infrastructure), supported by the European Commission in the context of the Horizon 2020 initiatives and by OPERAS (http://www.hirmeos.eu/), and the Open Access books on JSTOR initiative. HIRMEOS project aims to create coordination between the different subjects (universities, publishers, etc.) that deal with OA books, in particular for the HSS, promoting a wider integration in the European Open Science Cloud (EOSC). It involves five publishing platforms: OpenEdition Books (FR), OAPEN Library (NL), EKT ePublishing (GR), the German Göttingen University Press and Ubiquity Press, an English OA publisher. JSTOR, part of ITHAKA not-for-profit organization, has launched an initiative called Open Access books on JSTOR which consists in hosting within its database OA books published by some qualified university publishers [25]. What has been said could suggest a recent phase of the scientific monograph and perhaps the exit from a critical period that has now lasted for years [13, 26, 27]. As is known, the causes of the crisis of this research product are different: the preference accorded to the scientific article in an increasing number of disciplinary sectors; the high costs of producing paper publishing; the cuts suffered by the budgets of academic libraries, etc. [28, 29]. The picture must be completed by recalling that the sales of digital editions of scientific books, grown for a few years, have been reduced in recent times and overall they have not been able to recover the drop recorded in the paper market. One can better understand the lucky moment of the OAB if it is placed within the general state of crisis of the academic monograph. In other words, the use of the OA model by publishing houses must be seen as one of the attempts to revive a kind of publication in difficulty. Book processing charge (BPC), as well as article processing charge (APC), is the fee that researchers pay publishers for making their work available in OA. Other factors then convinced publishers to invest in this sector: the observation that, despite everything, monographs remain one of the leading products of research in some disciplinary sectors [30–33]; the renewed attention from states (mainly European and the western world) and institutions (public and private) in promoting policies and allocating OA funding; or even a greater visibility [34]. Let us not forget that in many HSS areas the monograph is however considered one of the most relevant communication channels of the scientific activity's results and it is of considerable importance for the researchers' evaluation [35]. The support of public institutions, which materialized with the approval of norms, rules, guidelines, has helped to revive OA within the world of research. OA policies demonstrate two main limits. In the first place, they are unevenly spread: Europe and a part of the Western world still remain privileged, while the situation in emerging countries is more problematic. And then they still pay little attention to open access monographs, even if there have been signs of openness in recent times.

4. New protagonists

From the beginning, the OAB sector has been characterized by the active role that publishers, associations and institutions have played within it, as shown by the events of some initiatives of the early 21st century [17]. The OAPEN Foundation (https://oapen.org/), born in 2008 under the name of Open Access Publishing in European Networks, is one of the first projects to deal with the development of OA books. Since 2011 OAPEN has been working to increase the standards of OAB, has promoted training activities and developed guidelines on quality assessment, on licenses, on the management of metadata. Among the founders together with institutions, such as the universities of Amsterdam and Leiden, the library of the University of Utrecht, the Academy of Sciences, the National Library of the Netherlands, we find the Amsterdam University Press. AUP is a publishing house founded in 1992, initially linked to the University of Amsterdam, which has a solid propensity for the publication of OA books (currently covers about a fifth of the entire production) and OA journals, and which has given life in recent years to a collaboration with partners such as Knowledge Unlatched (http://www.knowledgeunlatched.org/), an initiative created to encourage closer collaboration between academic libraries and publishers in supporting OA books (today transformed into a for-profit company) and the Association of American University Presses (AAUP). It may be useful to remember that Eelco Ferwerda, an active OAB supporter, started working at the Amsterdam University Press (AUP) to move to the presidency of the Association of European University Presses (AEUP) and finally to join the direction of the OAPEN Foundation. There is also the Open Access Scholarly Publishers Association (OASPA, https://oaspa.org/), founded in 2008, which includes among its members non-profit and profit scientific publishers and different institutions. OASPA began to take an interest in OA books starting from 2011, among its activities we remember the organization of seminars dedicated to different aspects of digital publishing, see for instance [36].

SPARC Europe (https://sparceurope.org/), one of the OASPA members, and OPERAS (Open Access in the European research area through scholarly communication, https://operas.hypotheses.org/) must also be cited. SPARC Europe, the continental division of the Scholarly publishing and academic resources coalition (SPARC, https://sparcopen.org/) active since 2001, brings together publishers, institutions and universities with the aim of supporting a new approach to scientific communication, in particular to the "networked digital environment". OPERAS presents itself as a "European research infrastructure" interested in the development of open scientific communication, particularly in the social sciences and humanities. Among the partners we find some European universities and research centers but also publishers such as the UCL Press and projects such as Knowledge Unlatched. OPERAS is part of a larger OA support project called OpenEdition (https://www.openedition.org/) created through an online platform that brings together services dedicated to scientific journals (Revues.org), publishing OA (OpenEdition Books), etc. OpenEdition is promoted by the Center for Open Electronic Publishing (Cléo), a French organization supported by Centre national de la recherche scientifique (CNRS), Université d'Aix-Marseille, EHESS, Université d'Avignon, and is committed to developing digital publishing. In recent years, the number of publishers (profit and non-profit) who have decided to focus on OAB has grown significantly. The Directory of Open Access Books (DOAB) currently lists about 400 publishers who dedicate themselves to the publication of OA books (and this is only a part, albeit the most qualified, of the OAB publishers). Some studies proposed dividing the companies engaged in the sector into four types. In the first one we find traditional publishing houses such as De Gruyter, Palgrave MacMillan, Springer, Ingenta who have started to invest in this sector by drawing on public funding or by adopting the book processing charge (BPC) model. We also include in the first type publishers who offer OAB collections contained in some full text bibliographic databases (e.g. Project MUSE, which offers the consultation of a few hundred OA books of university presses). The second type involves university presses with a longer tradition (e.g. Cambridge University Press, Oxford University Press) and publishing initiatives linked to often non-profit institutions and learned societies (e.g. The Economic History Society, The Modern Humanities Research Association). The third type includes the new generation university presses mainly oriented towards open access (e.g. UCL Press, etc.). The last kind includes the so-called academic-led presses (ALP), a label that collects both non-profit (in certain cases founded and directed by scholars) and.

profit publishing initiatives (e.g. Open Library of Humanities, Ubiquity Press, IntechOpen) [28, 37].

5. A new phase of OA

The publishers' growing involvement in the development of OAB, supported by public and private institutions (associations are included), represent a phenomenon not to be underestimated as it provides significant indications on the current phase of the OA. It is sufficient to know even only superficially the history of the OA movement to realize something is changing. Over the course of thirty years, three protagonists emerged: publishers, institutions and supporters of open access. At the beginning, the publishers were wary, and the institutions had not expressed a great interest in the phenomenon, perhaps considering it an internal issue in the academic world. The OA supporters had right away.

sustained the need to promote alternative methods for the dissemination of the scientific literature, paying particular attention to the articles. This preference is based on reasons of economic sustainability: the scholar who makes his article available in OA does not suffer economic damage (in general) since he does not receive compensation for its work; in exchange however, he obtains greater visibility and the guarantee of fair and free access to own scientific production. The OA publication of a scientific book, on the other hand, entails more demanding consequences both for publishing houses, which have to sustain more substantial investments, and for authors, who have to deal with the reduction in revenues deriving from sales. Following these arguments, the OA movement ended up neglecting the monographs as evidenced by the fact that to date a strategy dedicated to them has not been developed, as has happened for the deposits with the green road and for the journals with the gold road [9].

Over the years, something has moved within the groups. OA supporters have faced problems such as the unsatisfactory rate of penetration of their theses within the academic community and an internal division within the movement on choosing the most suitable economic model for journals in their transition to OA. These (and other) uncertainties weakened the OA movement's action and favored the strengthening of the role of the other two protagonists (institutions and publishers) [38]. The institutions finally understood the social benefits of open access and the importance of reforming the current research funding system characterized by a high worldwide public funds investment. Publishers have not merely accepted the OA model, transforming it into an opportunity for the relaunch of scientific publishing, but now they are part of the open access decision makers. Jean-Claude Guédon distinguished the publisher's approach to OA into several distinct periods [39, 40]. In the first one, from the post-war period to 1970, there was a robust recovery in academic activities throughout the western world, within which the publishers have carved out a role of "powerful actors in scientific publishing". The next phase (1970–1995), the last one in which the use of paper prevails, is characterized by the emergence of some large publishing houses and the first signs of the crisis of scientific communication (monopoly, growth in journal prices, etc.). The third period (1995–2005) coincides with the advent of the Digital age: the publishing world begins to deal with the new reality between openings and errors and among the latter we must count the closure towards the OA ("Big Deals dominate this period"). The last period, from 2005 to the present day, is characterized by the gradual absorption of open access within publishing strategies: "large commercial publishers have gradually added Open Access to their business plans, either as full OA journals, or more commonly, by opening their subscription journals to the possibility of making individual articles OA (hybrid-journals)" [39].

Today the scenario shows an alliance between public and private institutions and publishers aimed at supporting OA. A sort of open access that has been defined as "commercial", while the community of scholars, librarians and experts who had given birth to the OA is weakened in particular as regards the ability to influence choices. Joachim Schöpfel wrote that we are witnessing the transition from a "bottom-up structure" of the OA, based on the interest of researchers, to a "top-down" one in which the lines of action are increasingly influenced by the world of institutions and publishers [15]. According to this readings, the "community-driven model of OA", developed since 1990 and to which we owe the realization of the gold and the green road, will enter into crisis after a few years. The PLOS initiative is significant in this regard. In 2000 a group of scholars decided to launch an appeal to urge the academic and publishing world to make scientific articles available online and free in public archives (e.g. PubMed Central). The initiative had been an overwhelming success but had been unable to transform some habits: libraries continued to subscribe to the expensive of scientific journals subscriptions and the researchers, many of whom engaged personally in the battle for OA, did not stop collaborations with closed-access periodicals. We cannot speak of the end of the OA, but of a "new chapter" of its history. A chapter that tells the discovery in recent times, we are at the beginning of the 21st century, of the economic potential of OA. For this reason, some experts and scholars have spoken, as anticipated, of "commercialization" of open access [15, 38]. However, we believe it is reductive to think of this OA phase in terms of a mere attempt at economic exploitation: it is more useful to try to deepen some aspects. It should be remembered, for example, the lack of interest that the academic world continues to have today in the direction of the construction of a scientific communication system oriented towards the values of openness. This attitude weakens the positions of the OA movement and, on the other hand, in particular consolidates the role of publishers as we have seen in the OA books developments. Among the first documents that sanctioned this new alliance, it is customary to indicate the final act of June 2012 of the Working group on expanding access to published research findings, coordinated by sociologist Janet Finch and established by the British government. The newness introduced by the Finch report are two: the broad acceptance of OA by academia (and public institutions) and the preference for the option for a "gold OA" based on the article processing charge (APC). In other words, the opening of institutions towards open access was balanced by a decision appreciated by publishers (well represented within the working group) by the choice of an OA model compatible with business strategies.

The Finch report will subsequently influence other international initiatives including the Max-Planck-Gesellschaft OA2020 (2016) whose purpose is to allocate economic resources destined for the scientific journals subscriptions to the financing, through APC, of OA publications; and the European Commission Horizon 2020. The adoption of this kind of OA is not, of course, without consequences. If the growth of the commercial dimension of open access is sustained, the prerogatives of publishers prevail (also with the institutions' support). A scholar wrote that what the European Commission is doing is nothing more than finding "new ways of channeling public funds into private hands" [41]. New economic barriers are then introduced within the circuit of scientific communication, in particular for that part of the world (global South) which does not possess adequate financial means. This last aspect has aroused much debate in recent times. Leslie Chan (University of Toronto Scarborough), one of the signatories of the BOAI declaration, points out that the discussion is now moving almost exclusively on economic aspects or on the choice of models to be adopted to support OA articles and monographs [42–44]. In this way, the costs of open access publications are not reduced and there is an increase in disparities. According to Chan, however, the OA movement, created to counter the emergence of inequalities between the South and the North of the scientific world, has the obligation to continue promoting actions that favor access to resources (research products, communication channels between scientists, databases, etc.). In this phase, the original open access purposes would instead be overshadowed by the preference given to models mainly interested in the commercial exploitation of this kind of publishing resources. What developments does the future hold? It is not possible to address this issue here, however, we can indicate some attempts that propose alternative approaches.

Among these, we want to mention the Appel de Jussieu published in France at the end of 2017 by a group of experts [45]. The document aims to promote "bibliodiversity", i.e. the various innovative forms of scientific communication. The bibliodiversity takes into account a wider involvement of subjects operating in scientific publishing and also of new public investments to be allocated to the creation of web platforms and infrastructures for the open dissemination of research results. The appeal arises in response to the already mentioned OA2020 with respect to which it intends to promote a model that is not limited to the transformation of journal subscriptions funds into APC: "We find it necessary to foster an open access model that is not restricted to a single approach based on the transfer of subscriptions towards APCs (publication fees charged to authors to allow free access to their articles)".

This position is already present, the sign of a mentality that is changing, in previous documents such as the Joint COAR-UNESCO Statement on open access (2016) in which we read: "Some organizations are promoting a large-scale shift from subscriptions to open access via article processing charges (APC's). However, there are a number of issues that need to be addressed in this model" [46]. The most relevant novelties of Jussieu's appeal do not consist only in the encouragement expressed towards alternative ways of spreading research products and in the proposal of support the innovation in scientific publishing but also in the attempt to relocate the scientific community to the center of OA decision-making processes. The French appeal, citing a 2015 League of European Research Universities (LERU) document, explicitly states that: "funding should go to research, not to publishers!" [47]. Even the Plan national pour la science *ouverte*, made public by the French Government in July 2018, moves in this direction, it is no coincidence that Jussieu's appeal is cited: "The scientific community must regain control of the publishing process in general, in keeping with the principles promoted by the Jussieu Call for Open Science and Bibliodiversity. It must direct its efforts towards virtuous stakeholders working to develop a less concentrated publishing environment that adheres to the principles of open and ethical access, especially in terms of transparency, governance and intellectual property" [48]. If read out of the context of the whole document, the statement may suggest the recognition of extensive autonomy of the scientific community, in reality, a little further in the text it is explained that the French State is responsible for managing higher education in the country and also the financing of all initiatives capable of promoting the transition to open science. Therefore, new balances seem to be envisaged between the parties interested in the future of OA.

6. Conclusion

The chapter examined the phenomenon of open access books. Its aim is to show in particular how they have earned a place in scientific publishing and in the field of open access. At the beginning of the chapter the origins of so-called "free books" and a few years later of open access books were briefly presented. This part was followed by an exposition of the evolution of the "OAB" in recent years. In the second part of the chapter, OA books were investigated within a more general evolution of OA. The intention is also to understand how their growing presence in the world of digital libraries has made it possible to enrich the offer of the academic research products available in OA, especially in HSS.

Conflict of interest

The author declares no conflict of interest.

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Section 4

FAIR and Open Data

Chapter 6

FAIR and Open Research Metadata as Leverage for Digital Libraries: The Flemish Case

Sadia Vancauwenbergh

Abstract

Since the advent of the digital age, academic libraries have been transforming from traditional libraries to digital libraries. While digitisation of published materials has been taking place in most libraries, research data is not yet a common good. However, in an era where the Open Science movement affectuates the modus operandi of the entire research ecosystem, it is paramount for digital libraries to include information on other digital objects such as research data. In fact, FAIR and Open research (meta) data can truly act as a leverage for digital libraries and broaden the scope of the library from a place for content consumption to a place for content creation. In order to take on this role, digital libraries must cooperate with ICT and the research community to ensure that the infrastructure is in place to store research (meta)data and that the librarians have the digital skill set for handling FAIR and Open research (meta) data. Throughout the chapter, we will elaborate on the essentials for creating a digital repository, with emphasis on the underlying metadata scheme using the Flemish application profile for research data as example. In addition, we will highlight the essential roles for operating digital libraries containing research data.

Keywords: Digital libraries, Open Science, metadata model for research data, digital skills, FAIR and Open Data

1. Introduction

Over the past decades, many academic libraries have been actively involved in building institutional repositories that comprise books, papers, theses and other works which can be digitised or that were born digital. This offers many advantages in terms of the ease and speed with which users can access the available content. As such, digital libraries are losing their physical boundaries, also in terms of storage space, and can offer a round the clock availability. In addition, academic libraries allow for an easier search through the available content and thus re-use of the knowledge contained. Altogether, this has provided academic libraries with more possibilities to make their content available to the general public, in accordance with the Open Access [1] principles unless conditions are imposed by the publishers that limit access rights. In this way, digital libraries have accelerated the Open Science movement, which in essence started already in the 17th century with the establishment of the academic journal, as a means to share resources and scientific knowledge upon societal demand [2, 3]. Although Open Access is one of the best known components of Open Science, the latter concept in essence comprises all methods to disseminate scientific research results to the public. Thus, Open Science also includes Open Data, Open Research Software/Source, Open Evaluation, Open Educational Resources, Open Advocacy and Citizen Science.

Over the past years, research performing and funding organisations have particularly stressed the importance of Open Data, which aims to make research data freely available to everyone to use and republish, without any restrictions [4]. This movement has urged academic libraries in collaboration with ICT and the research community to develop a new component within their institutional repositories that allows for the storage and retrieval of research (meta)data for the general public, unless conditions are imposed that limit access rights, similarly to Open Access. Moreover, this new role of the academic library also urges the development of digital skills for librarians in order to ensure that they can assist researchers to make the (meta)data FAIR, i.e. findable, accessible, interoperable and reusable, and whenever possible open. This chapter provides an overview of the transformation of academic libraries to act as a leverage for FAIR and Open research metadata, with respect to the research information systems and repositories as well as the skillset of the librarians.

2. Digital repositories and Open Data

The role of digital libraries in Open Science is well recognised and has been endorsed by several international organisations and stakeholders. In 2012, the European Commission extensively promoted the role of libraries in the Commission's recommendation on Access to and Preservation of Scientific Information in Europe [5]. In 2015, the Organisation for Economic Co-operation and Development (OECD) further emphasised the role of the libraries, repositories and data centers as key actors on Open Science together with researchers, government ministries, funding agencies, universities and public research institutes, private non-profit organisations and foundations, private scientific publishers, businesses and supra-national entities [6]. In concrete, the OECD-report assigned the role of enablers to libraries, thereby describing it the libraries '*role to ensure the preservation, curation, publication and dissemination of digital scientific materials, including research data*'. In addition, the OECD-report pointed towards libraries and repositories to constitute the physical infrastructure that allows researchers to share and (re)use digital scientific material, including research data. Since 2016, the European Commission has increasingly invested in Open Science, and organises its policy according to eight ambitions (**Table 1**) [7].

In order to realise these strategic goals, the European Commission has been taking initiatives that allow for defining the general framework for future strategic research, development and innovation activities in relation to Open Science in general, and

- FAIR and open data should become the default for the results of EU-funded scientific research
- the European Open Science Cloud (EOSC), a federated ecosystem of research data infrastructures, should allow for the sharing and processing of research data across borders and scientific domains
- the development of new metrics for measuring Open Science practices
- the development of Open scholarly communication
- the inclusion of reward systems that recognise Open Science practices
- the investment in digital skills that enable FAIR and Open Science
- the emphasis on research integrity and the inclusion of the general public in Citizen Science

Table 1.
The eight ambitions of Open Science, as defined by the European Commission [7].

the European Open Science Cloud in particular. The resulting Strategic Research and Innovation Agenda (SRIA) of the European Open Science Cloud [8] further stresses the role of research libraries as one of the 6 major stakeholders in developing and implementing EOSC. Throughout the report, digital libraries and research infrastructures are seen as the cornerstones for EOSC, a federated system of data infrastructures. Although the importance of digital libraries is obvious, the reports also provides insights in challenges and boundary conditions for all stakeholders. In what follows, we will focus on what applies for digital libraries in particular.

2.1 Digital repositories as infrastructures for research (meta)data

Many academic libraries have been actively involved in building an institutional repository that makes research output from their affiliated researchers findable, accessible, interoperable and reusable. This is realised through library catalogues and other systems that ensure the storage, management, re-use and curation of hardcopy and digital materials. In order to facilitate these functionalities, digital libraries have to take into account software, which focuses on the preservation, organisation and search functionality on the library's content. Until now, many software solutions have been developed, either as an Open Source solution or proprietary, that all store metadata, i.e. descriptive information on the digital objects contained in the repository. While the metadata and ontologies on research publications have been developed together with research-related metadata (on researchers, projects, organisations, equipment, etc…) largely in the research information community since the 1980s, the metadata and ontologies on research data have grown organically in (sub)disciplinary or geographically spread (sub)communities, which has resulted in a wide variety of schemes available. A manually curated resource on metadata standards for research data is the FAIRsharing.org initiative, which currently provides information on 72 metadata standards, in addition to other standards on thesauri, markup languages, … (dd 2021-02-21). This high number of metadata standards urges the need for the development of a governance structure to coordinate the work on metadata and ontologies for research data.

2.1.1 Research data and the Flemish Research Information Space

In Flanders, Belgium, the Expertise Centre for Research & Development Monitoring (ECOOM)-Hasselt, was contracted to coordinate the creation of a semantically described, generic metadata model for research data. This metadata model will be integrated by the Flemish institutional repositories that provide information to the Flemish Research Information Space (FRIS), an online platform and current research information system (CRIS) governed by the Department Economy, Sciences and Innovation (EWI) of the Flemish government. In addition, FRIS makes Flemish research information publicly available to all stakeholders in science, economy and innovation [9, 10], and will in the (near) future connect with EOSC.

Currently, the FRIS-portal (researchportal.be) contains information on more than 85.800 researchers, 2500 research organisations, 42800 research projects and 457900 publications (**Figure 1**). This information is provided by the Flemish research universities, higher education colleges, strategic research centers, research institution in an incremental manner. As a common interchange model, the CERIF standard is being used, which is developed and maintained by euroCRIS [11]. Importantly, all information provided (ex. projects, publications, …) is semantically described, where the concepts behind the terminology are semantically aligned between all information providers. Using data and classification governance methodologies, one can ensure that the research information delivered to FRIS is uniform and comparable.

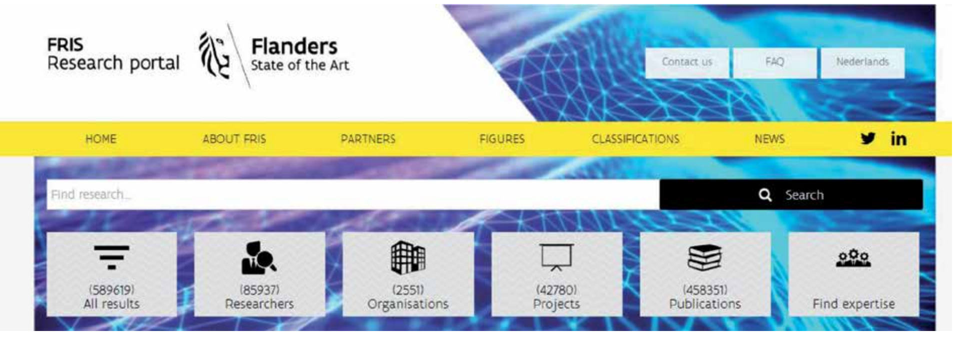

Figure 1.
Flemish Research Information Space, researchportal.be [Accessed 2020-12-23].

In line with the growing importance of research data management, and in particular FAIR and Open Data in Europe, the Flemish Government issued in 2018 two decrees, the Special Research Fund (BOF) Decree [12] and the Industrial Research Fund (IOF) Decree [13], that impose on Flemish universities to provide metadata on research data to FRIS the latest by the end of 2021.

Based on the general European need for a coordinated approach towards metadata models and ontologies, and the requirement of the BOF- and IOF-Decree to deliver metadata on research data by 2021, the Flemish Government contracted ECOOM-Hasselt to develop a generic metadata model for research data that would ensure the uniform delivery of information to FRIS.

2.1.2 The Flemish application profile for research data

In accordance with previously developed metadata models for research information, ECOOM-Hasselt used data governance as a methodology to build a semantically described metadata model for research data. Data governance comprises the specification of decision rights and an accountability framework that encourages desirable behaviour in the creation, storage, use, archival and disposal of (research) data [14]. In addition, it includes the processes, roles and standards that ensure the correct use of (research) data by facilitating the incorporation of explicit semantic definitions and, where required concordance table to other metadata models for research data.

In order to apply the data governance methodology, a working group was composed with participation of experts on FRIS from the Department EWI as well as experts on research data (models) from the Flemish research institutions that provide information to FRIS. This group was termed the Flemish Open Science Board (FOSB) working group Metadata & standardisation and in fact is one of the three working groups under the FOSB that unites all Flemish stakeholders in a shared vision for the future with regards to Open Science and the EOSC Association. The FOSB WG Metadata & standardisation first inventoried existing, yet generic metadata models for research data (ex. DataCite [15], re3data [16], ...) and examined their scope, their uptake in the European research ecosystem as well as their use purpose. Based on this analysis, the WG decided to build an application profile for the Flemish research institutions based upon DataCite's Metadata scheme 4.3, a standard that also has been adopted by OpenAIRE, and which was released on August 16th, 2019 [15, 17].

DataCite is an international not-for-profit organisation which aims to improve data findability, accessibility and re-usability through the assignment of persistent identifiers, such as Digital Object Identifiers (DOIs) to datasets and through the development and maintenance of a metadata standard. This metadata standard contains extensive possibilities to describe metadata of research data and, importantly, the metadata fields have been semantically defined in order to clarify the concepts behind the terminology used. In addition, this standard has already been implemented by several European and international organisations and allows for interoperability. As the FOSB WG Metadata & standardisation was assigned to deliver a metadata scheme that ensures the FAIRness of research (meta)data on FRIS, with a uniform semantic understanding by all information providing institutions in line with the Flemish research context, the WG decided to develop a Flemish application profile based on the DataCite standard. Moreover, some extensions on DataCite's standard were needed to allow the monitoring of indicators on Open Science, including Open Data. Altogether this resulted in the establishment of an application profile [18] consisting of metadata fields on 21 properties, out of which 15 originated from DataCite. Three of the original Datacite properties were deduplicated, i.e. Description, Subject and Rights and 3 new properties were defined, i.e. Open format, Legitimate opt-out and FAIR data label, that are directly related to the monitoring of indicators on Open Science in Flanders. Similar to the DataCite standard, the Flemish application profile included an indication on the obligation to provide the information to the FRIS-portal using the values mandatory, mandatory if applicable, required and optional. Furthermore, the semantics as defined by DataCite were refined according to the Flemish context, only when needed. Altogether, this resulted in the creation of the Flemish application profile for research metadata.

2.1.3 Integrating the Flemish application profile into FRIS and digital libraries

As the Flemish application profile for research metadata will be included in FRIS, the FOSB WG Metadata and standardisation also strived to maximally integrate the information on research-related information that is residing in this system as this adds substantially to the FAIRness of the data, while at the same time keeps the administrative burden for research as low as possible according to the 'only-once' principle.

In brief, the WG identified the information on research (meta) data that could be enriched via an elaborated set of additional research-related metadata on researchers, research organisations, projects, publications that are already provided to FRIS by the Flemish research institutions. In addition, some additional metadata fields were added to already existing information objects, such as the addition of a DMP identifier metadata field to the object Project. By integrating the metadata models on existing information objects with the Flemish Application Profile for research metadata, we were able to maximise the reuptake of information already residing in FRIS.

In a next phase, the Flemish information providers have to implement the Flemish application profile for research metadata in their institutional repositories. This not only requires profound knowledge on the institutional repository software, but also knowledge on the institution's own use purposes with regards to the stored (meta)data and the coinciding processes. Indeed, the Flemish institutions are not merely storing the metadata on research data in their institutional repositories just to comply with the BOF/IOF-Decree that obliges them to deliver this information to FRIS. In fact, it is of huge importance for research institutions themselves to manage their data. In 2018, the Flemish universities together with the Flemish Interuniversity Council (VLIR) conducted a survey on current research data management practices at the Flemish universities [19]. The resulting paper stated that '*good data management is not a goal in itself, but rather is the conduit leading to knowledge discovery and innovation, and to subsequent data and knowledge integration and reuse by the community after the data publication process*'. As such, research data management is an essential part of responsible research and innovation and should be included in all research-related processes. Consequently, the implementation of the Flemish application profile for research metadata must take into account the variety of processes, that might be specific for every research institution involved. Therefore, the implementation of the Flemish application profile for research metadata should be accompanied with business and validation rules that ensure its correct implementation and use. Although a basis rule set will be defined for FRIS, research institutions can decide to make the rules more stringent according to their own needs and processes.

3. Digital skills for FAIR and Open Science

Next to the development of the (meta)data repository component in digital libraries, it goes without saying that librarians also need to have the necessary skills set for handling research (meta)data, including the processes related to research data management. Although this general need for research organisations, including digital libraries, to strategically develop digital skills for FAIR and Open Science is well recognised [20, 21], a survey by Stoy et al. [22] demonstrated that this is not yet a widespread phenomenon and more investments are needed.

In 2020, an EOSC Executive Board Skills & Training Working Group was composed in order to delineate amongst others the minimal skill set for EOSC including specifications for training catalogue(s) [23]. This Working Group identified 10 roles in the EOSC ecosystem, which are important to enable EOSC, and thus FAIR and Open Data. Out of the 10 roles identified by the EOSC Executive Board Skills & Training Working Group, some roles are associated more frequently with digital libraries, for example the data steward/data librarian, data curator and EOSC educator role. Although there may be differences to which kind of roles are applying to specific digital libraries, depending on the organisational structure, we will focus here on these 3 roles and the required skill set.

The data librarian/data steward role concerns the person who prepares and handles FAIR research data and maintains data and metadata. This maintenance includes the preservation and storage of the (meta)data according to the FAIR and CARE (Collective benefit, Authority to control, Responsibility and Ethics) [24] principles and in line with ethical and legal frameworks on data. Thus data librarians in Europe should also be aware of the Responsible Research & Innovation program [25], the Open Science framework of the European Commission, the European General Data Protection Regulation (GDPR) [26], the Nagoya Protocol [27] and the control of trade in dual-use goods (Dual Use products) [28]. In addition, data librarians should develop skills to facilitate the development of the digital library infrastructure, including library services that allow for the easy discovery, curation, preservation and retrieval on the contained digital objects together with ICT and the research community. Finally, data librarians should be acquainted with domain-specific standards and best practices in order to ensure that data can properly take into account the specifics of research disciplines.

The data curator role concerns the person who has a broad overview on the content of the institutional repository and who ensures the long-term and qualitative preservation of data in a consistent manner in line with the FAIR and CARE principles and in compliance with the policy and/or legal frameworks [24–28]. In brief, data curators should have profound knowledge and technical skills to ensure that data are being stored and archived in such a manner that allows for long-term usage in terms of readability, re-usability and exchange of the data, for instance with third parties.

Next, digital libraries should also include the role of (EOSC) educator, i.e. the person who has a profound understanding of the research data ecosystem (ex. EOSC), its mode of operation and the related principles and frameworks [24–28]. In particular the (EOSC) educator should have educational and communication skills in order to transfer this knowledge to researchers across disciplines, for example through the development of adequate training material for different target audiences.

As state above, the 3 roles described here in detail do not exclude digital libraries to consider other roles that might be needed according to their specific organisational setting. In fact, qualitative research data management cannot be reached in isolation, but merely requires the embedding of all roles recognised by the EOSC Executive Board Skills & Training Working Group within an organisational setting. However, the three roles described above provide digital libraries with a means to prioritise the development of the required digital skill sets for FAIR and Open Data. Although there are currently no focused training programs for these profiles in Flanders, shifts are taking place that will make training possible on the short to medium term, mainly due to the obligations imposed by the Flemish Open Science Policy as well as the advent of the EOSC Association. In the meanwhile, online courses and training initiatives such as those offered by DCC and others might serve as an interim solution [29].

4. Conclusion

Since the advent of the digital age, traditional libraries have been transforming to digital libraries. Digitisation has reshaped the structure, format and processes that libraries use to ensure the preservation, curation, publication and dissemination of digital content. While in the early days, digitisation processes mostly took place on (research) publications, the past decades a shift has taken place to all kinds of digital scientific materials, including research data. This shift has been accelerated with the Open Science movement, and Open Data in particular, which aims to make scientific findings freely available to everyone to be used and republished, without any restrictions. Furthermore, the current investment of Europe in the establishment of EOSC has more than ever stressed the importance of managing research data in order to enhance the flow of research data and scientific knowledge between researchers, institutions and disciplines. The importance of FAIR and Open Data in fact acts a lever to further develop the role of academic libraries as hubs of digital information. In order to take on this role, digital libraries must ensure that the infrastructure is in place to store research data, in collaboration with the ICT department and the research community, and that librarians have the required digital skill set for handling FAIR and Open Data.

In order for academic libraries to manage infrastructures for research (meta) data, it is prerequisite to incorporate software and a metadata model for research data that is in line with the research institution's goals and processes and that allows the interoperable exchange with other digital resources worldwide. Over the past decade, many research communities have been developing metadata models for research data and crosswalks between different models are missing. This prompted the Flemish Government, to contract ECOOM-Hasselt to coordinate the creation of a Flemish application profile for research metadata that will be used by all Flemish research institutions. The resulting application profile is based on the DataCite metadata standard 4.3, yet comprises some minor customisations in terms of properties and semantics, according to the Flemish context and use purposes. The proper implementation of the metadata model in the institutional repositories, can however only be ensured when business and validation rules are developed and implemented that guarantee its correct use. Moreover, it also allows for the uniform delivery of metadata on research data to the FRIS-portal by all Flemish information providers, i.e. the universities, higher education colleges, strategic research centers and research institutions.

Next to the development of digital libraries as infrastructures for research (meta)data in collaboration with ICT and the research community, one obviously also needs to have the required competences in terms of human resources on board. In this respect, digital libraries should focus on the investment in digital skill sets for, in particular data librarians/data stewards, data curators and (EOSC) educators. In brief, these digital skill sets aim to preserve, store and curate research data, according to policy and/or regulator obligations, and enable future use of high quality (disciplinary) research data, in an easily accessible and consistent manner, including the transfer of the knowledge thereof to the research community. Altogether, FAIR and Open research (meta)data can truly act as a leverage for digital libraries and their future perspectives.

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Abbreviations

CARE	Collective benefit Authority to control Responsibility Ethics
CRIS	Current Research Information System
DOI	Digital Object Identifier
CERIF	Common European Research Information Format
EOSC	European Open Science Cloud
EWI	Department Economy, Sciences and Innovation of the Flemish Government
FAIR	Findable, Accessible, Interoperable, Reusable
FOSB	Flemish Open Science Board
FRIS	Flemish Research Information Space
OECD	Organisation for Economic Co-operation and Development
SRIA	Strategic Research and Innovation Agenda
VLIR	Flemish Interuniversity Council

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Section 5

Open Education and Digital Libraries

Chapter 7

An Educational Project Based on a Digital Library of Filmed Courses

Carlos Luna, Clara Raimondi and Fernando Carpani

Abstract

In this chapter we describe the experience developed around OpenFING, a project based on a digital library of filmed courses. We highlight OpenFING as an initiative of students for students that has obtained the support of the Engineering School of *Universidad de la República* (Uruguay). Currently, OpenFING seeks its consolidation along with an undergraduate course of initiation to audiovisual and multimedia production. The project aims to be an engine to develop educational innovations and different computer tools to support teaching and learning. The objective is to transform OpenFING into an effective collaborative and interactive open learning platform. From the evidence collected by this work, we can conclude that OpenFING is perceived by students and some teachers as an appropriate resource complementary to learning.

Keywords: lecture videos, flipped learning, digital skills, open educational resources, digital libraries

1. Introduction

Many universities disseminate their courses openly on the Internet as part of a policy that encompasses the publication of the knowledge imparted. For instance, the Massachusetts Institute of Technology's OpenCourseWare [1] and the Open University's initiative OpenLearn [2]. Likewise, private organizations also publish courses: Khan [3], Udemy [4], etc. Open policies can change from site to site, and resources can be video-based, as well as text-based, but most of the resources use video. This variety of available resources promotes the implementation of new teaching and learning methodologies, such as blended learning [5–7] and flipped learning [8, 9]. Blended learning is a combination of online and traditional learning (face-to-face learning). Both learning methods are complementary. The online learning includes, for instance, the use of videos, online reading material and online assignments. In flipped learning (flipped classroom) the delivery method in traditional learning is reversed. For example, a student is asked to watch a learning video, read certain material, or participate in an online learning exercise before class. Class time is used to work on the concepts involved, with the guidance of a teacher. In all these methodologies there is generally an online platform where students and teachers can interact.

This work presents OpenFING, an educational initiative based on a digital library of filmed courses, that has the support of students, teachers and learning technologists who collaborate in the development of the OpenFING Project at *Facultad de Ingeniería* (FING), which is the Engineering School of the *Universidad* *de la República* (UdelaR), the major university in Uruguay (with approximately 145.000 students). FING is a large faculty, with approximately 10.000 enrolled students and more than 900 teachers to cover 20 programmes in Engineering. Student participation is expected and appreciated at any stage. A lot of students also work full time. The lecture halls for the initial years of most programmes are overcrowded. Most FING courses have two mid-term exams with a pass mark of 60%. A lower score prevents the student from taking the final exam.

As many Latin America schools, FING is experiencing an increase in matriculation rates and scarce resources, observing low graduation and high drop-out rates. New strategies have become necessary to adapt the scholar system to this reality. The video-recording of traditional lectures is a low-cost activity for teachers and it can be seen as a supplement for a traditional course. According to some studies, recorded lectures can become a helpful tutoring resource, mainly because videos have a slower, more step-by-step lecture style than the classroom lectures; student use of videos is voluntary and can be tailored by students to meet their learning and topic-review needs, and can occur when and where students learn most effectively.

OpenFING is essentially a digital video library of standard lectures or masterclasses. The project emerged from a student's initiative: recording courses and publishing the videos openly on the internet. Originally, the use of videos was regarded as a support for the personal study of the student, not as a substitute for the classes. However, the digital resource also addresses issues such as overcrowded lecture halls and the attendance of students who also work full time. Also, the project is a means of introducing innovation in educational strategies, such as the flipped learning model, used in various parts of the world with good results from a learning point of view [8, 9].

In order to sustainably support the OpenFING project and the continuous participation of students, in mid-2016 the course Introduction to Audiovisual and Multimedia Production (IPAM) was created, awarding credits for FING's degree programmes. This allows students who participate in OpenFING to learn digital skills related to the use of cameras and non-linear video editing, as well as the development of other digital educational resources.

The main objective of this chapter is to share OpenFING's experience and tasks planned for the project's evolution. The aim is to improve academic level and enhance the learning experience, taking advantage of the participants' efforts. This chapter is essentially an extended and updated version of [10].

The rest of the chapter is organized as follows. Section 2 discusses the concept of openness in general and its implementation in access to teaching material. Section 3 presents how OpenFING operates and Section 4 describes the OpenFing platform. Then Section 5 introduces the IPAM course and Section 6 analyzes educational experiences that are being developed by considering the integration of OpenFING in teaching and learning processes. Section 7 considers related work and finally Section 8 presents learned lessons and final remarks.

2. Open science, open access and open educational resources

Open science and open access to information sources is still not universally accepted; one part of the world has access to the great variety of paid information resources while the other part depends, at least partially, on free of charge information resources available on Internet. In both cases, members of educational institutions are interested in materials that already incorporate content with a specific didactic or pedagogical approach. These materials are often referred to as digital learning materials [11]. Digital learning materials are available from multiple personal, corporate and institutional web pages on the Internet, as well as in digital repositories [12].

Open access means that information resources are digital, Internet, free of charge, and free of most copyright and licensing restrictions [13]. In the last two decades, open access initiative has played a prominent role in the dissemination of educational material that is normally found in the libraries of academic institutions [14]. This initiative supports the idea of open science which is gaining on popularity as open access information resources increase.

2.1 Open science

Open science is the idea that scientific knowledge of all kinds should be shared openly as early as is practical in the discovery process [15]. The benefits of open science include sharing of knowledge, especially the knowledge that is publicly funded and the ability to use and reuse the results in particular of teaching where quality information resources are needed. Open science depends on open science information resources that provide opportunities to facilitate access to knowledge.

The idea of open science began to spread and generalize globally. In particular, the proliferation of open access information resources is a prominent manifestation of this process.

2.2 Open access

Paid information resources have become one of the major obstacles in work of the higher education institutions, mainly due to the high cost of subscription to scientific publications that many university libraries have to cover [16]. In particular, students and teaching staff need ubiquitous daily access to information resources which must satisfy the following characteristics: they must be free of charge, they must have validated content and be easily accessible, they must use common formats, etc. The open access initiative became increasingly attractive to facilitate access to scientific information resources used for teaching and research.

The greatest benefits of open access can be observed in research and teaching at academic institutions. However, open access is not understood and presented equally everywhere. There are differences in openness and rights of users in accessing and using scientific and educational materials in open access digital repositories.

2.3 Open educational resources

Open educational resources began to develop a decade after the open access initiative emerged. In 2001, MIT started OpenCourseWare, an initiative that was followed by several universities around the world that contributed to the advancement of open educational resources. Additionally, organizations such as UNESCO, the OECD, the Commonwealth of Learning, and the European Union have supported the development of open educational resources [17].

Open educational resources (OER) are essentially educational materials that are available on the Internet with a low level of restriction. According to UNESCO, *open educational resources are technology-enabled, open provision of educational resources, for consultation, use and adaptation by a community of users for non-commercial purposes*. These resources are generally freely available on the Web or the Internet, and are primarily used by teachers and educational institutions to support course development. Additionally, they can be used directly by students in their usual academic activities. Open educational resources include, for example, learning objects such as videos, lecture material, experiments, references and readings, simulations, and demonstrations.

3. OpenFING

OpenFING was created in 2012 as part of an undergraduate thesis in Computer Science [18], with the intention of providing support in teaching and learning activities using a Semantic Web Technologies platform based on videos. The initiative attempted to solve the problem that a large percentage of students have: most cannot attend classes regularly or must do so in overcrowded lecture halls. Having the complete classes recorded on video and available on the web allows students to follow the course Internet at their own convenience. The initiative also sought to provide an additional tool for students to prepare for their tests, particularly during exam periods.

Nowadays, the OpenFING platform [19] has more than 70 filmed courses (mainly at undergraduate level), making a total of more than 1400 individual lectures. What differentiates this initiative from others is the number of volunteers that have participated: over 200 people including IPAM students.

Between 2013 and 2015, a camera and video editing workshop was held each semester. These workshops were attended by some students enrolled in the Computer Science degree, which prompted the degree directors to assign academic credits to those students who had recorded or edited a course. This was a way to encourage student participation in the OpenFING project. Approximately 40% of the regular courses of Computer Science degree were recorded and published by OpenFING in that period. Also, the option of recording new optional courses was added every semester. It must be understood that nearly 50% of all FING students are enrolled in a Computer Science programme; accordingly, recording those courses turned out to be a high-impact action. From 2016 until now, academic credits are obtained through the IPAM course (see Section 5), and the contents cover further academic programmes from FING.

Accomplishing the organization of such a complex schedule has certain logistical challenges; thus every semester important decisions have to be taken by the coordinating group:

- Which courses to be recorded needs to be agreed, involving authorization from the corresponding teachers and planning for the use of equipment (cameras, microphones, memory cards, tripods). If the teachers refuse their permission to have lectures recorded, then the course goes back to a queue of courses that may be recorded the following period.

- Agreement must be reached on how the course should be published. It is either published on the public OpenFING site or in the Virtual Learning Environment (VLE) where only teachers and students can access it.

- The coordinating group needs to recruit FING students who are interested in participating in OpenFING, and establish who records and edits each course. The recruitment campaign is run using OpenFING's Facebook page and the official FING website.

- During the semester, coordinators need to keep in touch with those students who are filming and editing the lectures, making sure they are performing their tasks in a right and committed way. The editing process is carried out by groups of four students. The task list is defined and distributed among the group members.

- All equipment needs to be checked to ensure good performance. Before each lecture scheduled to be recorded, students check every camera, microphone, battery pack and memory card and their availability.

The members of this team are mostly committed students who remain working on the project for some years, and pass on their knowledge to new members. Recently, FING started to pay a small stipend to two of them, and also had a staff member from *Unidad de Enseñanza* (UEFI) – a center for teaching and learning development at FING – join the team. The recording and editing tasks are carried out by students of the IPAM course. Also, volunteer students participate of their own accord, receiving no academic recognition or payment.

The strength of OpenFING's working model is the students' involvement in the recording and editing of lectures. For example, during the recording they must decide if the teacher or the blackboard must be on frame at a particular time. It is mandatory for the student to have certain knowledge of the lecture topic to do this. The cameraman's knowledge of the topic is essential. For this reason, it is necessary that students in a recording team have previously taken the course. This form of organization is considered an added value when compared to a lecture recorded by a standalone, fixed, big long shot. This fixed model is for example used by *Facultad de Psicología* (Psychology School of UdelaR), or when the recording is done by people who have no knowledge of the course to be filmed.

The OpenFING streaming model is based on an Open Education workflow and on the collaboration between professors and students. The courses are available in digital format, under a Creative Commons open license (BY-NC-ND 4.0). This increases the opportunities for studying and learning, and also the visibility of the University's production. Since 2013, following international trends, UdelaR's governing body is internally promoting the adoption of policies intended to implement more use of open virtual resources. The use of Free and Open Source Software (FOSS) and the creation of an Open Access repository, plus a series of policies aimed at opening up education, allow the material to be used by anyone, democratizing access to knowledge. With more than 110,000 undergraduate students [20] and close to 11.000 teachers [21], the University accounts for the vast majority of the country's total student enrollment, and is considered the main site for the promotion of Open Access and the development of Open Educational Resources (OER). Compared to other South American countries, Uruguay seems to present an enabling environment for Open Education [22].

OpenFING has been adopted by students as an additional study tool. The average number of weekly accesses to OpenFING went from 5.000 in 2014 to 25.000 in 2019. In 2020 this number doubled, due to the COVID-19 pandemic and the need to develop the courses (essentially) virtually, with higher measurements in periods close to the evaluations of the courses.

4. The OpenFING platform

The OpenFING platform was intended to be a collaborative tool based on a variety of materials, but focused on the videos of lectures. The project has a platform with a server which is integrated into the server pool of FING. In this pool, three services are executed: a video server, a production web server and a development web server. These servers are managed and maintained by the *Unidad de Recursos Informáticos* (Information and Communication Technologies Unit) of FING, in coordination with a Computer Science professor and a volunteer student. There is also another dedicated computer used for exchanging footage between cameramen and editors, as well as for other tasks (post-editing, viewing, graphics).

A new version of the platform is being developed, which includes mechanisms of comment's moderation, together with an easier way to publish videos and an independent chat room. Also, some additional tools might be added, like a Cornell Notes editor [23] and some data analysis process in order to monitor learning and teaching activities. We expect to have an updated platform soon with a collaborative mechanism and facility to relate topics in different videos. Moreover, functionality to add notes to a video will be developed in order to manage teaching in a better way.

Our main goal is to convert OpenFING into a Semantic Web based collaborative platform to publish and annotate videos. With this platform, teachers and students can annotate videos with topics, comments, web resources, and other kind of metadata to improve their teaching and learning activities. One of our main concerns from the technical point of view was to develop an architecture in which new features could be easily introduced to the platform. This leads us to the use of Semantic Web (SW) technologies [24] to develop the platform, in particular Linked Data paradigm [25].

Some functionalities, via a set of use cases, are:

- *Search and find*: a user starts the session selecting a course in the Course Menu. Also, the Search Box can be used to perform queries. Queries input may be plain text (e.x. "induction") or contain tags to refer to specific objects in the platform (e.x. course:, lecture:). Then, the search is performed using a combination of SPARQL queries and text search on the labels and titles values. In our example, the search for "induction" returns a video lecture where the title "Inductive Set Definitions" matches the search criteria. This video contains the complete lecture about the concept he is looking for, but also other related concepts.

- *Fragmentation and annotation*: while the user is watching the video, he decides to mark the video fragment where the teacher defines the "Declarative View of Inductive Sets", and annotate it with the topic "Declarative view". To do this, he uses the Annotation Type Selector to declare the type of the annotation as a "Topic", and then he writes the topic in the Fragment Creator text area. At this time, the fragment start time is recorded. When the user pushes the blue button, the end time is recorded and the video fragment and its annotations are saved. Both objects are associated with the user. In the system, video fragments are identified by URLs which follow the Media Fragment URI 1.0 recommendation of W3C.

- *See annotations of other users*: while the user watches videos, he can also see annotations created by other users in the Annotation Viewer. These annotations appear dynamically as the start time of related fragments is reached. When the user clicks in an annotation, the related video fragment starts in the player.

- *Using external resources*: OpenFING may coexist with learning platforms, such as Moodle. Users may then also annotate video fragments using URLs that refer to lecture slides, or questions in a forum. This mechanism also allows to add reference to any URL on the internet, in particular to add references to other video fragments in OpenFING, and was developed at zero cost because the use of standard dereferenceable URIs.

- *Recommended videos and resources*: while users watch videos, related videos and resources are shown in the recommendations panel, which is accessible from the View Selector. The contents of this panel change dynamically according to the annotations found in the video. The recommendation criteria implemented so far is very simple, and retrieves video-fragments that refer to the same topic, but other criteria can be easily added to the platform.

- *Teachers Activities*: students may use OpenFING without involving the teachers, but their participation may improve the experience. For example, teachers can curate users annotations assessing its correctness, or help in the organization of topics according to some taxonomy. Also, teachers can evaluate the comprehension of a certain topic by checking the annotations created by students. Finally, teachers can also propose the creation of annotations as a learning activity, as suggested in [26].

It is expected that the previously mentioned strategies will have an impact on student learning, by providing a space for reflection and exchange of different points of view on the content of the courses. The objective is to transform the project into an effective collaborative and interactive learning platform.

5. The IPAM course

In 2016 the deanery of FING, learning technologists from the UEFI, the responsible professor for the project at the *Instituto de Computación* (InCo) – the Computer Science department at FING – and staff from the *Facultad de Información y Comunicación* (FIC) – the School of Information and Communication of the UdelaR – started to work together around OpenFING to generate an optional undergraduate course in response to three observed problems:

- the sustainability of OpenFING over time;

- the lack of basic audiovisual knowledge and production skills among engineering students; and

- the differences in quality of OpenFING outputs.

The aim of the course is to develop the ability to create learning resources in various formats, developing skills of content hierarchy, design, production of original materials and therefore communication and digital literacy skills [27]. The theoretical–practical course is offered to students in different FING programmes, as well as those from other schools. Students enrolled in IPAM work in teams. In summary:

- they engage in the recording and editing of a regular undergraduate or graduate course of FING, to be published in the OpenFING digital library;

- they produce an audiovisual or multimedia resource related to the courses, programmes, research, or develop topics of interest for FING, intended to be used both by students and staff.

These types of resources are aligned with the future plans for the OpenFING platform. IPAM encourages the development of OpenFING, as well as the production of other open educational resources. FIC professors teach general knowledge about communications and audiovisual production that allow students to use the camera, choose shots and follow the scene and take good sound shots. Regarding post-production, they teach about montage and edition through the free program *Kdenlive*. Multimedia resources, based on hypertext and non-linear products with an interactive structure [27, 28], set a strong frame for the development of personal learning strategies. Detailed information about the course, including its programme, is available Internet at the VLE site of the course IPAM-EVA [29]. Some of the audiovisual and multimedia products developed are available on the OpenFING platform.

In recent years more than 200 students have participated in IPAM, helping to film and edit courses for OpenFING, and producing unpublished audiovisual and multimedia resources. The project is kept alive thanks to the contribution of the students.

6. Methodologies to support teaching and learning

Higher education remains generally focused on the transmission of information by the professor to the students, although in recent decades emphasis has been placed on changing this situation and thinking of strategies that situate the learner at the center of the educational process [30, 31]. In particular, FING teachers usually have three types of interaction with students:

- A theoretical class. The classic lecture with a teacher explaining mainly theoretical concepts.
- A practical class. A teacher or a teaching assistant explains the solution of exercises on the blackboard.
- A query class. One or more teaching assistants check with a small group of students (may vary from 15 to 50) the exercise resolutions that students present. This strategy is not developed on all courses.

Staff spend most of the contact time with content explanations; thus the interactions between teachers and students are limited. Also, in this context the role of students tends to be very passive. The conditions of massive attendance in which the courses are developed, in particular from first semester to sixth, seem to be an obstacle to implementing innovations in teaching. At an international level, the need to transform the relationship between teaching and learning of engineering is shared, emphasizing the active role of the student [30, 32]. At our university, in line with the proposals of international literature, the topic of active learning methodologies is becoming more relevant. Since 2011 specific orientations have been included in the ordinance of undergraduate studies that indicate teachers that the central pedagogical strategy will be to promote active teaching, where experiences in which the student, individually or in groups, is confronted to solve problems, exercise their initiative and creativity, acquire the habit of thinking with originality, the ability and pleasure to permanently study and the ability to mobilize specific knowledge to solve new and complex problems will be privileged [33]. It is also indicated that it is relevant to make an adequate integration of theoretical and practical teaching, allowing a permanent articulation between the two and enabling the development of the skills and abilities that correspond to the graduate's profile. In the case of FING, it also seeks to encourage the development of active learning methodologies by affirming from the FING's governing bodies that it is necessary to support and promote this experiences in the School's courses, specially, in the early stages of the degrees [34].

In the new paradigm of teaching the focus is on producing learning. In this context the development of the strategies promoting active learning in university becomes relevant. Teachers need to create instructional activities involving students in doing things and thinking about what they are doing [35]. In this way: the students are involved in more than listening; less emphasis is placed on transmitting information and more on developing students' skills; students are involved in higher-order thinking; students are engaged in activities; and greater emphasis is placed on students' exploration of their own attitudes and values.

In order to integrate technology and resources to achieve more active teaching and learning practice, professors need to redesign their course methodologies. The following paragraphs describe experiences that represent successful cases in FING.

In 2015, the Discrete Mathematics course was offered in a blended learning format, using the classes that were recorded previously in 2014. The new version of the course presents changes that modify two aspects of the traditional course: the way in which the teacher leads the class and the way a participant studies. Each week, the learners had Internet sessions to prepare for class, with topics, notes, books and recorded lectures on the VLE platform. In addition, practical exercises and periodical consultation classes were offered. The experience was positively evaluated [36]. In particular, although the approval scores did not vary, similar results were obtained with fewer teaching hours, allowing the course to be taught twice a year and therefore providing the opportunity for students to return to study so as not to fall behind on their journey.

In 2017, an alternative modality was developed for the Logical Mathematics course (required for Computer Science students in the third semester). In parallel with the traditional and massive course, the alternative was offered to a subgroup of students. The new modality focused on promoting students' active work using a flipped learning approach. Tasks that students usually performed at home were performed in class and vice versa. The teacher's theoretical lecture was replaced by the availability of other resources, such as lecture videos, class notes and books. Class time was then dedicated entirely to interaction activities, such as discussing the issues students found difficult and working on practical exercises. This strategy transforms the class into an exchange, contact and engagement space. In this experience, the following resources were integrated: VLE, recorded lectures of the theoretical content available on OpenFING, and the use of specific software. These resources facilitated the student–teacher exchange of information prior to the face-to-face classes. The software used was a prototype developed by the students of a programming course and complemented by functionality added by the teaching team. The software consists of a tool based on the Cornell Notes model; it provides students with a space to record relevant ideas, summaries and questions about the videos, the bibliographic material and the exercises to solve in each class [8]. The teacher received the digital Cornell Notes generated by each student weekly, and prepared the classes accordingly, based on the issues or difficulties they had raised and their summaries.

The academic results of the new modality of the Logical Mathematics course show an increase in the percentage of students who obtain the needed credits without the final exam. From the student opinions gathered in surveys, the vast majority positively valued the modality. They highlight aspects of its design: first, the theoretical content was sufficient from the available materials; second, difficulties could be reviewed in class; third, compulsory attendance and scheduled deliverables favored continuous work as well as group dynamics. From the teaching point of view, the experience was ranked as very positive. The increase in contact time with students allows the design of lectures to be adapted to the specific needs of the group and generates a positive learning environment for the presentation and analysis. The modality was taken by 50 students, so the challenge is to scale to 350 students, which is the estimated average number of students enrolled in the course each year for the last five years.

Another experience that we point out refers to the Computer Programming II course, which takes place in a blended format. As of 2016, the theoretical classes recorded by OpenFING were included in the VLE of the institution. In the last four years the rate of approval without final exam increased from 29% in 2016 to 43% in 2020. Student surveys show the importance of the videos in their learning process, mainly due to the impossibility of attending the face-to-face course. As mentioned earlier, approximately half of the students are in work and participate in the course in a virtual modality. These students also describe the usefulness of the recordings for the preparation of the course assessments and, predominantly, the final exam.

Faced with the suspension of classes due to the COVID-19 pandemic, the teachers asked their students to continue the rhythms of work from the visualization of the filmed classes. Subsequently, based on the needs of the students, synchronous classes were incorporated via conference. The filming made it possible to continue advancing at an adequate pace as well as providing access to the content to those students who cannot connect to video-conferences due to connection problems or schedules. Some teachers of initial and mass courses began to make new uses of the filmed classes and to incorporate them into their planning as a central resource. These practices have not yet been evaluated but show progress in the use of filmed classes for pedagogical purposes. For example, teachers took an excerpt from the class footage where a concept, problem or exercise was explained and during the synchronous conference they showed it to reflect and discuss with the students. In this way they achieved greater interaction and commitment of the student in the class. Other teachers began to use the H5P tool [37] that allows adding interactive elements to the videos. They took a filmed class and added questions, study extensions text, etc. Thus, the teachers were able to enrich the class filming, favor the student's interaction whit the resource and design the student's work outside the classroom. These two experiences focus on reusing the filmed class as well as helping the student to actively visualize and develop study strategies from the videos.

The professors who implemented these new teaching experiences believe that OpenFING has great potential as a tool to improve the development of courses, allowing them to focus their time on the direct exchange with students, promoting the understanding of issues and strengthening the student–teacher relationship. In institutional terms, it is considered important to consolidate these strategies, which include changes in teaching methodologies. The flipped learning model constitutes a change in teaching tasks, as teachers prepare the lectures based on the learning experience of the students and their progress. There is also a concomitant change in the role of students, mostly for the ones who are used to being passive participants in the traditional educational model. The changes and new educational processes are monitored at the pedagogical level by UEFI, which provides a space for support, exchange and development of educational practices.

7. Related work

The use of lecture hall videos as an educational resource is not new. Chtouki et al. [38] highlight the commitment of the students in an experience that studied the impact of the integration of YouTube technology in the teaching of English as a foreign language, making use of educational videos. Following a controlled academic experiment, they conclude that the experience was successful. In [39] the use of video recordings of live lectures is regularly perceived by students as supporting their learning when preparing for assessments. Furthermore, [40] argue that regular use of video-based resources may enhance learning if the student has appropriate learning skills and strategies. In this vein, [41] developed a guidance framework in order to develop students' effective and efficient use of lecture captures. He found that students use recorded lectures in their own ways depending on private study practice as well as the intended learning from the specific course.

New learning models have been created, such as the flipped learning model, which focus on the development of active teaching and learning methodologies through the use, although not exclusively, of videos for educational purposes [8]. In [42] the authors describe an experience using a system for Internet lecture videos and, although a good level of acceptance by students is highlighted, they mention aspects that can operate negatively if the use of these resources is not related to the educational methodologies and practices followed by the teachers. As highlighted in the experience of the three FING courses, the integration of digital technology (the recorded lectures and the VLE in this case) can function as a window of opportunity to change the traditional pedagogical paradigm towards new ways of teaching and learning. In each case, the use of the video resources needs to be pedagogically aligned [43], and the reasons for its inclusion and how its integration will benefit teaching and learning need to be defined [44].

Some works deal with the use of annotations in e-Learning. In [28] the authors review a set of learning experiences that use annotations, and extract some recommendations about the use of annotations as a learning activity. In [45], an experiment about social annotation in an educational environment is presented which concludes that is a good way to promote the student engagement in the educative process. None of these works deal with video annotations. Several works treat video annotations, but only a few focus on educational videos. The work presented in [46] is close to OpenFING, but they do not use Semantic Web Technologies. About the use of Semantic Web technologies in e-Learning, some works should be taken into account. OpenCourseWare (OCW) Universia Team experience about producing and consuming Linked Data is presented in [47]. The paper introduces LOCWD, a vocabulary to describe OCW resources. In [48] a platform with some similarities to OpenFING is described where the search mechanism exploits LOD.

8. Learned lessons and final remarks

OpenFING started as a project of students wishing to record, edit and publish lectures in order to make them available to other students as learning and study resources. The good experience of the teachers who participated initially facilitated the growth of the project within FING. From 2016 onwards, the OpenFING project began to be articulated by different actors from the institution: the group of students who coordinate the project, learning technologists from UEFI, professors from FING and FIC as lecturers of the IPAM course, with the explicit support of the deanery of FING. This initiative has the potential to be a multidisciplinary educational development, involving staff from different faculties and university students in a common educational project. The current version of the OpenFING platform allows students to watch videos from more than 1400 filmed lectures.

OpenFING has been adopted by students as an additional study tool. The average number of weekly accesses to OpenFING went from 5.000 in 2014 to 25.000 in 2019. In 2020 this number doubled, due to the COVID-19 pandemic and the need to develop the courses virtually, with higher measurements in periods close to the evaluations of the courses. Actually, more than 80% of users surveyed, think that OpenFING enables them to follow a course appropriately and even more users (88%) think their learning is improved by the project. Additionally, 84% of users agree on a high level of satisfaction with the learning experience using OpenFING. OpenFING is considered a flexible resource by 86% of all users because it allows studying at any time [10].

On the other hand, most of the teachers surveyed (see [10]) have a positive opinion about OpenFING (63%), and 70% also highlight the project as a useful tool for study habits and course follow-up. A negative aspect of the survey carried out among teachers shows that only 26% of those surveyed state that they have changed their teaching practice due to the existence of recorded courses. Regarding the impact of using OpenFING in their classes, 77% of teachers indicate a lower rate of attendance at their lectures. Several teachers are concerned: 35% consider that the situation may be risky, since the replacement of class attendance by video increases the lack of interaction between students and between students and teachers. A change in teaching strategies, and the development of new pedagogical resources mentioned above such as audiovisuals on specific topics, could modify the statistics of preference for online classes (44%). In relation to improvements for the project, 27% of the teachers surveyed propose the creation of short audiovisual content about specific topics in a more detailed way, and also video creation for Internet courses like MOOCs [10].

Many platforms that offer virtual courses and educational resources are well known: Coursera [49], Khan Academy [3], FutureLearn [50], Merlot [51], among others. OpenFING stands out as an educational project made by students for students. Students manage and coordinate their peers for the recording and editing of videos, and perform tasks ranging from the identification of courses to record and contacting the appropriate teachers to the final publication of the videos on the web. This not only makes it possible to keep the project alive each semester, with the support of teachers and the institution, but also generates a remuneration for students who actively participate. This collaborative participation in the production of resources that contribute to the students' learning occurs either through the IPAM course (which supports OpenFING) or voluntarily. Those following the IPAM course will benefit from acquiring knowledge of digital and communication skills, and audiovisual and multimedia resource production, as well as obtaining credits.

A prototype platform was created which enables comments, questions, the addition of related links and course topics that might be associated with video fragments by the users and teachers. The prototype allows suggestions to be presented to the users. However, the development carried out must still be adapted for mass use. At a technical level, it will be necessary to investigate the application of other techniques to select and/or filter interesting materials associated with the videos, using, for example, natural language processing, data mining and machine learning mechanisms, as well as exploring possibilities of processing audio and video to retrieve information.

An updated platform with a collaborative and thematic relationship mechanism is expected soon [52]. Annotation strategies of video fragments will be designed, focused on the development of software for the management of teaching. This software will add each student annotation about a video fragment into a graph database. The database may enable the analysis of each student graph and detect "wrong links" exposing any wrong understanding about some topic in order to personalize the teaching task. With this platform, teachers and students can annotate videos with topics, comments, web resources, and other kind of metadata to improve their teaching and learning activities. The development of video-lectures is usually considered as a high cost activity for teachers. Our low-cost approach, based on the publication of video-recorded traditional lectures, has still proven to be useful to students. It is expected that the previously described strategies will have an impact on student learning, by providing a mechanism for reflection and exchange of different views on the contents of the courses. The main objective is to transform the project into a collaborative and interactive platform for learning. This line of development is also highlighted by other researchers [26, 53, 54].

From a technological point of view, we believe that Semantic Web technologies allowed us to develop a flexible environment, in which we can add new features in a simple way. We also think that HTML5, JS, NodeJS, SPARQL stack works as a good prototyping platform since it reduces programming and testing times. New versions of OpenFING server and clients are being developed using NodeJS and HTML5. In the near future we expect to extend the Semantic Enricher component using two approaches: querying LOD, and using Natural Language Processing of documents.

From the evidence collected by this work, we can conclude that OpenFING is perceived by students and some teachers as an appropriate resource complementary to learning, both for preparing for assessments and outside of revision periods. Further research is needed on how to develop students' competencies when using OpenFING, for example, in order to champion a better practice for note taking, so as to improve the support for student learning and make the most of the study experience. Obtaining evidence from the students' experiences could shed light on the specific uses, preferences, strategies and needs of the engineering students. Additionally, further research would uncover why those teachers willing to implement changes in their teaching practices have not done so yet. To maximize the understanding of their needs and how best to support them in the development of active teaching strategies with the use of OpenFING and other resources, FING has the UEFI, specifically conceived to support staff regarding technology-enhanced learning practices.

To conclude, the development of active teaching strategies needs to take into account the context of each course, depending on its size, budget and viability. The challenge lies in disclosing and further developing the processes involved in the relationship between the teacher's learning design of the course, the lectures as teaching interventions, OpenFING recorded lectures as learning resources, and the students as independent learners.

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Over the past decades, traditional academic library environments have transformed into digital libraries. This has resulted in many challenges for libraries in terms of the reinvention of libraries' roles and organizations, the skill sets of librarians, and library infrastructure. At the same time, this profound transformation has opened the door to many new avenues, such as the support and advancement of Open Science. This book offers insights into the transformation of traditional library environments to digital libraries and details how digital libraries can contribute to Open Science, in particular to Open Access, FAIR and Open Data, and Open Education, by describing methods, criteria, strengths, and weaknesses as well as applications.

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