# Towards an Open Science technological ecosystem for a Mexican University *

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## ABSTRACT

The objective of Open Science (OS) is to bring research closer to society through open access investigation practices, seeking open interaction during all stages of research. Scientific practices based on OS are increasingly determined by laws and decrees that regulate a research culture, which results in the need for institutional technological ecosystems that should be interoperable and respond to the guidelines derived from the OS movement. A lot of research institutions in the world already have regulations on these practices, while others are developing or seeking consensus. In this work we present a doctoral research plan, focused on studying the culture of open science research and open practices in a Mexican university, so that, derived from the information obtained offer a proposal of a technological ecosystem to contribute to the research exercise of the institution, facing the 0S scheme. The objective is to offer the researchers of the institution the necessary elements to do their work under the OS context, by offering an ecosystem that allows the social appropriation of Science and Technology in the region. The advances in research to date allow us to recognize the taxonomic elements of OS and the theoretical origins of this proposal. The methodological approach is mixed and integral for the analysis of qualitative and quantitative elements of the study universe.

## CCS CONCEPTS

• Social and professional topics • User characteristics • Cultural characteristics.

## KEYWORDS

Open science, Scientific culture, Open practices Technological ecosystems, Citizen science.

## 1 Research context and motivation for the implementation of this research project

Open Science (OS) has become a recurrent and current topic in the debates on scientific production. The rise of the OS practices happens when international organizations such as the United Nations Educational, Scientific and Cultural Organization (UNESCO), the European Union (EU), and the Organization for Economic Cooperation and Development (OECD), as well as governments of different countries, have recognized in the Open Science the opportunity to make research efforts more accessible to society and with this presumably support the resolution of current problems. The question in this sense is no longer about the suitability of the proposal, but about the ways to spread it and extend it to the whole world [1, 2]. In this context, it is extremely important to think about technological ecosystems that allow researchers to respond assertively to this new scheme, which is no longer under discussion but under implementation. The institutions adopt measures, regulations and work proposals around OS, such as the one issued by the FOSTER working group [3] which, after the analysis for the EU, offered a comprehensive training

model focused on the taxonomic elements that the group considers as key elements for Open Science (CA).

In recent years (2019-2020), UNESCO has worked on a recommendation on open science, with the intention of generating a consensus at the global level, through ongoing consultations expected to end in April 2021, in order to be in a position to present a recommendation that should be approved by the member states in the same year. The European Commission (EC) and its cOAlition S [4, 5] propose the same deadline for having all publicly funded research results within the EU in open access. In the case of Mexico, additions to the Science and Technology Law were published in 2014, giving 0S an important role in the country's scientific development; and in 2017 the General Guidelines for Open Science were published, which consider six fundamental lines, which are still far removed from the components or taxonomies considered at the international level. On the other hand, there are alternative OS proposals in the country, as it is the case of AmeliCA of the Universidad Autonoma del Estado de México [6], which offers alternative evaluation options to Scopus and Web of Science.

The Universidad Autonoma de Zacatecas is a Mexican public university that does not have guidelines for open research practices, since it is barely recognizing 0S, as the country does, and it does not have access to a funding system that allows the institution to respond to the reality of the scientific publishing market and of OS itself with the golden access proposal. In this sense, it is a strategic contribution of this research to investigate the culture and practices of OS of the institution's researchers to answer the question of to what extent and how it is the culture of Open Science research transmitted from the institutions to the research professors in the universities?

Below we present the state of the art of the subject, the methodology, hypothesis and objectives of the doctoral work in order to offer the reader a look at the way in which the research is programmed and the results to be reached with the development of the proposed thesis.

## 2 State of the art

### 2.1 Open Science research culture

The Open Science (OS) research culture has an increasingly important place in the academic life of researchers and their institutions. The openness of science has been recognized as the last scientific revolution challenge or the new paradigm on science in the world [7, 8, 9, 10, 11, 12, 13, 14] and therefore this way of working gains a better position every day. Currently, a good part of the publication efforts are limited to OS practices, since numerous governments and institutions have legislated or standardized in this regard, and with this, the role of OS as a guide to scientific practice is indisputable, and a culture in this sense should be promoted and encouraged.

### 2.2 Open practices

Interest in different forms and dimensions of open practices in research and science has grown exponentially in response to the current global debate and paradigm. Practices that seek to bring more researchers together through the principle of sharing academic work at all stages [15, 16]. On the practices or trends of Open Science there are different proposals such as those of the European Commission, UNESCO and those derived from research proposals from diverse groups such as FOSTER [3], authors and institutions. Researchers are increasingly looking for more and better ways of collaboration, which has led to practices related to OS are increasingly used, in cases such as open educational practices [17, 18, 19], open publication [20] and open data [21, 22, 23], just to give some examples.

### 2.3 Technological ecosystems

Technological ecosystems are a core topic for open research practices. It is necessary to have adequate, interoperable and integrated technological responses, not only for the OS movement but for the current and institutional reality in which they are inserted [24, 25, 26, 27, 28, 29, 30]. Researchers need to have knowledge about open practices and also access to technological systems with components that allow them to adapt to the culture and practices of OS that are gaining more importance every day, and with this, ideally, have more opportunity to make, publish, share and improve the findings of their scientific work. A technological ecosystem must be proposed based on global experiences and the reality of the university or institution in which it will be inserted; therefore it is of vital importance to know the global and local context.

## 3 Hypothesis

The hypothesis of the present work is that the culture of research in open science, as well as open practices, are transmitted from the institution to the professors and therefore the institution can offer a technological ecosystem that allows to improve the opportunities of public science communication of the members of the institution and with this to shape their culture and practices.

## 4 Objectives

### 4.1 General objective

The general objective of the research is to evaluate the open practices of research professors, through the analysis of variables of scientific production, use, dissemination, and open practices that allow measuring in what degree and how the culture of open science research is transmitted from the institution to the professors in a Mexican institution, with the intention of proposing a technological ecosystem to support

open science, which guides the practices of research professors and contributes to the social appropriation of knowledge.

## 4.2 Specific Objectives

- To analyze the theoretical foundations of the Open Science research culture and practices, in order to locate advances and research opportunities.
- To analyze the variables of scientific production, use, dissemination and open practices, in order to locate the transmission of research culture of institutions in university professors
- To assess the research culture and open science practices of the researchers of the institution.
- To propose a technological ecosystem to promote the Open Science research culture that contributes to society.

## 5 Research approach and method

The mixed method will be used to carry out the proposed research. It seeks to obtain both qualitative and quantitative data, which will complement each other to enrich the work [31, 32, 33]. The proposed design is one of concurrent triangulation that seeks to cross-check quantitative and qualitative data for findings and interpretations [34]. The research work is planned in two phases that will allow to obtain the mapping of the elements for the ecosystem to be proposed. In the first phase, 3 instruments will be used (survey, interview and focus group) with the results of the first phase the interface of the technological ecosystem (TE) will be designed and in the second phase the same instruments will be used to validate the proposal with another sample population.

Following the line of the mixed method, causal-comparative work will be done to know the population susceptible to use the technological ecosystem and its potential needs, and explanatory-sequential work that will seek to collect data in 2 phases of quantitative research and explain the results looking for an analysis and explanation that includes the elements qual and quant [35,36]. During the first stage (QUAL-quan) Likert scales will be applied to research staff from different areas of the institution, with interviews to the same population to extract the staff susceptible to use the technological ecosystem and locate needs for the first TE proposal. In the second stage, we will work through focus groups with the located population to ratify and detect key elements to improve the Open Science technological ecosystem proposal for the institution and likert scales to validate or improve the proposal outlined in the first stage.

## 5.1 Population and sample

The study population will be staff members with a full-time teaching and research position at an institution in north-central Mexico. The sample will be made according to the databases of the Department of Human Resources taking into account the areas into which the institution is divided, adding that information in a process of "qualitative information triangulation" [37]. With the selected researchers, an analysis of the culture and research practices will be carried out at the same time that focus groups will be developed with the stakeholders of the different areas in which the institution is divided (Health Sciences, Basic Sciences, Social Sciences, Humanities and Education, Art and Culture, Agricultural Sciences and Engineering and Technology), since belonging to different areas of the sciences which can impact on the culture and practices of its researchers.

## 5.2 Study variables, techniques and instruments

To carry out the research we plan to work with 3 variables: open science culture, open practices and technological ecosystems.

A.  Open Science Culture. This is the assimilation of elements and practices of open science by researchers. Starting from the fact that open OS is the new paradigm on science [7] and seeing as necessary the adaptation of a culture in this sense, it is then necessary to know the degree of knowledge of the different elements [3,13] and their use.

B.  Open research practices. This refers to the realization of the research process by means of actions considered to be of the taxonomy of Open Science. Here we will seek to investigate the use of open research practices [14, 15, 34] and the difference by areas of knowledge.

C.  Technological ecosystems. It is also necessary to know the use of technological platforms [24] by researchers, because for the purpose of this research it is vital to investigate the use and knowledge of these platforms. For the OS framework some platforms are: the repositories of literature, data and mixed [10], platforms such as OJS [Open Journal System] for the publication of journals, institutional CRIS platforms [Current Research Information System], platforms for pre-prints for collaborative research, open peer review practices, all these as examples of the 28 possible practices of OS [3, 13, 14, 38, 39]. Legislation and institutional policies must be taken into account for the endurance of these ecosystems should also be taken into account.

The variables mentioned will be analyzed through the application of the following instruments:

Focus groups. They will be used with the authorities of the institution and also with researchers recognized as leaders in their area of study. With this type of work, it is intended to find a mapping of the state of the policies, trends and expectations they could have of a technological ecosystem of OS (variable C. Technological Ecosystems).

Semi-structured interviews. They will be used to apply to some researchers selected as representative of each area of the institution. To identify knowledge about open science and open practices (variables A. Open Science Culture and B. Open research practices).

Likert Scale Questionnaires. They will be applied to researchers from different areas to evaluate the impact and perception of current institutional policies on research and in a second stage to evaluate the proposed technological ecosystem (variables A. Open Science Culture, B. Open research practices, C. Technological Ecosystems).

Semantic differential scales. They will be implemented among a representative group of researchers in order to know the idea and concept of open science and open practices as well as the importance given to each of the elements (variables A. Open Science Culture and B. Open research practices).

## 5.3 Information Sources

The information sources will be researchers from the institution to analyze their research practices and culture, who will also be asked to evaluate the technological ecosystem proposal for validation in the second stage of the research

As well as directors and decision makers of the institution that will allow the implementation of the proposed ecosystem and who will provide data on the current culture or practices officially promoted.

For the state of the art, we will work with the information available in the Scopus and Web of Science databases, seeking to cross them in some cases with open databases, such as AmeliCA, Regional Repositories, among others.

Official documents about OS in Mexico will be analyzed, such as laws, additions to laws and guidelines officially available in the country. In this way, a comprehensive map of the state of the debate and discussion on OS and its components at the international and national level can be obtained.

Finally, an evaluation of the internal use of the Institutional Repository is planned, which wa available from 2018 onwards, to determine the degree of commitment and use of this element inherent to OS practices.

The following tools will be used during the implementation of the research:

- SPSS: Software to make concentrated and quantitative data analysis.

- Atlas Ti: Software to concentrate and analyze qualitative data.

- T-lab plus: Software to perform discourse analysis.

- Google forms: to conduct surveys.

- Literature databases: To consult the publications on the subject.

- Institutional Repository. The platform information will be used to know the use of the researchers of this type of OS technological options.

This work is carried out in the framework of the PhD Program in Education in the Knowledge Society of the University of Salamanca [40, 41], which as a requirement to all students asks to upload to its portal http://knowledgesociety.usal.es the progress of the work. This web page as a means of information on the activities and publications allows visibility and communication of the progress of the thesis work. The results of this research will be available in open access, as it is part of the Research Group on Interaction and eLearning (GRIAL) [41].

## 5.4 Information capture and analysis

The process of capturing and analyzing information will be done in the following way:

Identification and analysis of elements for the elaboration of instruments, in this first phase official documents from international organizations (UNESCO, EU, OECD), as well as from the Mexican government in the areas of interest such as the Law of Science and Technology and CONACYT's proposals on OS, will be evaluated. This evaluation will be carried out using T-LabPlus and ATLASti software to search for concurrences, associations, sequences and concordances in the official speeches.

In a second stage we will work with the formulation of a survey based on likert scale and semi-structured interview to recover the information on open practices and open science culture within the institution, we will look for the validation of the instruments by experts in the subject, using a survey. To analyze this information we will use the SPSS program.

Then we will proceed with the pilot test with a small group of researchers from all areas of the institution, both for the survey and the interview and use this same context to make the first focus group that will allow us to have a panorama of the state or response of the researchers to OS. Once the instruments are validated, the work of applying the same instruments will be carried out, which will be emptied in SPSS to obtain the qualitative information, which will be analyzed with the quantitative information obtained from the interview and the focus groups, so that with the analysis of these data the proposal (prototype) of the technological ecosystem can be formulated.

Once the initial proposal for the TE is obtained, instruments for its evaluation will be designed and piloted for application to a

strategic group of stakeholders of the institution. The results of this second round of information compilation will be analyzed using SPSS and ATLASti so that the qualitative results can be analyzed and crossed with the quantitative ones obtained from the focal groups and interviews by areas of knowledge in which the institution is divided.

With the analysis of the results, the adaptations to the proposed TE will be made for the design of rubrics and manuals that will be validated by experts and finally be able to present a proposal for the Technological Ecosystem for the institution to directors and possible users for its validation and to proceed with the final design of the Technological Ecosystem.

The ethical aspects of the research are a very important issue, for this reason the consent of the participants will be requested so that their contribution is voluntary and always taking care of the use of personal data, always following good practice guidelines in research [42].

## 6 Results to date and validation

The mapping of literature carried out to date has allowed us to observe that in European countries and in others such as the United States and Canada, OS practices are closely linked to those of the large publishers, such as Elsevier, Taylor & Francis, Wiley, Springer, among others, and in that sense, transformative agreements and institutional practices are being made, involving the payment of millions of dollars to these companies. In the case of Mexico and Latin American countries, the process has been singular and has taken different directions and bets than those seen in the other countries, perhaps due to the lack of economic resources.

Therefore, research that analyzes the state of OS policies in the country and a Mexican institution is a necessary contribution, since it will contribute to the debate on OS policies and practices for the Latin American reality in general and for Mexico in particular.

Furthermore, no efforts such as the one formulated in this paper have been found in the country, to propose an institutional technological ecosystem that offers researchers tools for the practice of OS from an integrative perspective that allows them to have support facing the new challenge presented by this new paradigm.

## 7 Current progress of the thesis

The work for the thesis is currently in the process of literature review. For this purpose, a mapping and Systematic Literature Review (SLR) is being worked on. This practice will allow to know the state of the art in a more comprehensive way.

## 8 Current and planned contributions

This research aims to provide elements for the implementation of a technological ecosystem project that allows researchers to have the tools for the development of their work under the principles of Open Science, taking into account that Mexico does not have current and comparable guidelines to those of other latitudes it is important to make the proposal for a Mexican university that does not have adequate and current technological elements to start working under an OS proposal.

## 9. Conclusions

The present project of doctoral thesis seeks to be an element that enriches the debate on Open Science in the Latin American region, with the idea of being the first institution to offer an integral technological ecosystem of open science that not only provides tools but also a world vision on the guidelines of Open Science and in this way contribute to the democratization of science, co-creation and scientific innovation in the different areas of knowledge of the university.

## ACKNOWLEDGMENTS

## REFERENCES

[1] UNESCO. 2019a. Preliminary study of the technical, financial and legal aspects of the desirability of a UNESCO recommendation on Open Science. General Conference, 40th, 2019.
[2] Mick Watson. 2015. When will 'Open Science' become simply 'science'?. Genome Biol 16, 101. DOIhttps://doi.org/10.1186/s13059-015-0669-2
[3] Foster (2018). Open Science Training Handbook. Alemania. German National Library of Science and Technology, Hannover.
[4] Science Europe. 2018. cOAlition S. Accelerating the transition to full and immediate Open Access to scientific publications. Retrieved from: https://www.coalition-s.org/wp-content/uploads/PlanS_Principles_and_Implementation_310519.pdf
[5] Marc Schiltz (2018). Science Without Publication Paywalls: cOAlition S for the Realisation of Full and Immediate Open Access. PLoS Med. 15, 9: e1002663.DOI: https://doi.org/10.1371/journal.pmed.1002663

[6]     A.Becerril-García, E. Aguado-López, K. Batthyány, R. Melero, F. Beigel, G. Vélez Cuartas, G. Banzato, C. Rozemblum, C. Amescua García, O. Gallardo & J.Torres. 2018. AmeliCA: A community-driven sustainable framework for Open Knowledge in Latin America and the Global South, Redalyc, Universidad Autónoma del Estado de México, CLACSO, Universidad Nacional de La Plata y Universidad de Antioquia, Mexico.

[7]     L. Anglada, & E. Abadal. 2018). ¿Qué es la ciencia abierta?. AnuarioThinkEPI, 12, 292-298. DOI: https://doi.org/10.3145/thinkepi.2018.43

[8]     Sonke Bartling, & Friesike Sascha eds. 2014. Opening Science. The Evolving Guide on How the Internet is Changing Research, Collaboration and Scholarly Publishing. Springer. Berlín.

[9]     Fecher B. & Friesike S. 2014. Open Science: One Term, Five Schools of Thought. In Opening Science. The Evolving Guide on How the Web is Changing Research, Collaboration and Scholarly S. Bartling and F. S. Eds. Springer, Cham, 17-47. DOI:10.1007/978-3-319-00026-8_2.

[10]   Ignasi Labastida. 2018. Challenges and Oportunities in Research Centers Open Science and Research Data Management, 26th April 2018. Oficina de Difusió del Coneixement, CRAI Universidas de Barcelona.

[11]   Jose Antonio Merlo Vega, (Ed). 2018. Ecosistemas del Acceso Abierto. Salamanca. España.Universidad de Salamanca.

[12]   María Soledad Ramírez Montoya. 2015. Acceso abierto y su repercusión en la Sociedad del Conocimiento: Reflexiones de casos prácticos en Latinoamérica. Education In The Knowledge Society (EKS), 16, 1, 103-118. DOI: http://dx.doi.org/10.14201/eks2015161103118

[13]   María Soledad Ramírez-Montoya, Francisco José García-Peñalvo ,& Rory McGreal. 2018. Shared Science and Knowledge. Open Access, Technology and Education. Comunicar. 26(54), 1-5. Retrieved from: https://www.revistacomunicar.com/pdf/comunicar54-en.pdf

[14]   Rubén Vicente-Saez & Clara Martínez-Fuentes. 2018. Open Science now: A systematic literature review for an integrated definition, Journal of Business Research. 88, (July 2018), 428-436. DOI: https://doi.org/10.1016/j.jbusres.2017.12.043

[15]   Nicholas David Bowman & Justin Robert Keene. 2018. A Layered Framework for Considering Open Science Practices, Communication Research Reports, 35, 4, 363-372, DOI: https://doi.org/10.1080/08824096.2018.1513273

[16]   Jessica Evans, Sally Jordan & Freda Wolfenden. 2016. Developing academics' assessment practices in open, distance and e-learning: an institutional change agenda, Open Learning: The Journal of Open, Distance and e-Learning, 31, 2, 91-107, DOI: https://doi.org/10.1080/02680513.2016.1195547

[17]   Alejandro Armellini & Ming Nie. 2013. Open educational practices for curriculum enhancement, Open Learning: The Journal of Open, Distance and e-Learning, 28, 1, 7-20, DOI: https://doi.org/10.1080/02680513.2013.796286

[18]   Suzan Koseoglu & Aras Bozkurt. 2018. An exploratory literature review on open educational practices, Distance Education, 39, 4, 441-461, DOI: https://doi.org/10.1080/01587919.2018.1520042

[19]   Fengchun Miao, Sanjaya Mishra & Rory McGreal. 2016. Open Educational Resources: Policy, Costs and Transformation, UNESCO, Paris. HANDLE: http://oasis.col.org/handle/11599

[20]   Nikos Koutras,. 2020. Open Access Publishing in the European Union: The Example of Scientific Works. Publishing Research Quarterly, 36, 3, 418-436. DOI: https://doi.org/10.1007/s12109-020-09745-x

[21]   Nicholas David Bowma. & Patrick R. Spence. 2020. Challenges and Best Practices Associated with Sharing Research Materials and Research Data for Communication Scholars, Communication Studies, 71, 4, 708-716, DOI: https://doi.org/10.1080/10510974.2020.1799488

[22]   Frederika Weller Donker & Bastiaan van Loenen. 2017. How to assess the success of the open data ecosystem?, International Journal of Digital Earth, 10(3), 284-306, DOI: https://doi.org/10.1080/17538947.2016.1224938

[23]   Natasha Susan Mauthner & Odette Parry. 2013. Open Access Digital Data Sharing: Principles, Policies and Practices , Social Epistemology, 27, 1. 47-67, DOI: https://doi.org/10.1080/02691728.2012.760663

[24]   Mark Berthelemy. 2013. Definition of a learning ecosystem. Learning conversations: Thoughts, ideas and reflections from Mark Berthelemy Retrieved from: :http://www.learningconversations.co.uk/main/index.php/2010/01/10/the-characteristics-of-a-learning-ecosystem?blog=5

[25]   Alicia García-Holgado, Francisco José García-Peñalvo, & Paul Butler. 2020. Technological ecosystems in citizen Science: A framework to involve children and young people. Sustainability, 12, 5, Paper 1863. DOI: https://doi.org/10.3390/su12051863

[26]   Alicia García-Holgado and Francisco José García-Peñalvo. 2019. Validation of the learning ecosystem metamodel using transformation rules. Future Generation Computer Systems 91, 300-310. DOI: https://doi.org/10.1016/j.future.2018.09.011

[27]   Alicia García-Holgado and Francisco José García-Peñalvo. 2017. A metamodel proposal for developing learning ecosystems. In Learning and Collaboration Technologies. Novel Learning Ecosystems. 4th International Conference, LCT 2017. Held as Part of HCI International 2017, Vancouver, BC, Canada, July 9–14, 2017. Proceedings, Part I, P. Zaphiris and A. Ioannou Eds. Springer International Publishing, Switzerland, 100-109. DOI: https://doi.org/10.1007/978-3-319-58509-3_10

[28]   Francisco José García-Peñalvo. 2018. Ecosistemas tecnológicos universitarios. In UNIVERSITIC 2017. Análisis de las TIC en las Universidades Españolas, J. Gómez Ed. Crue Universidades Españolas, Madrid, 164-170.

[29]   Francisco José García-Peñalvo. 2016. Technological ecosystems. IEEE Revista Iberoamericana de Tecnologías del Aprendizaje (IEEE RITA), 11(1), 31–32. DOI:10.1109/RITA.2016.2518458

[30]   Mart Laanpere. 2012. Digital learning ecosystems: Rethinking virtual learning environments in the age of social media. Open Soc.Technol. Netw. Learn. IFIP-OST, Tallinn, Estonia.

[31]   John Creswell, Michael Fetters, & Nataliya Ivankova. 2004. Designing A Mixed Methods Study In Primary Care. The Annals Of Family Medicine, 2, 1, 7-12. DOI: http://dx.doi.org/10.1370/afm.104. Retrieved from http://www.annfammed.org/content/2/1/7.full.pdf+html

[32]   R. Burke Johnson & Anthony J.Onwuegbuzie. 2004. Mixed Methods Research: A Research Paradigm Whose Time Has Come.Educational Researcher, 33, 7, 14-26. DOI: https://doi.org/10.3102/0013189X033007014

[33]   María Soledad Ramírez-Montoya, & Jairo Lugo-Ocando. 2020. Systematic review of mixed methods in the framework of educational innovation. [Revisión sistemática de métodos mixtos en el marco de la innovación educativa]. Comunicar, 65, 111349. https://doi.org/10.3916/C65-2020-01 Retrieved from: https://hdl.handle.net/11285/636432 https://hdl.handle.net/11285/636431

[34]   Anthony J. Onwuegbuzie, & Nancy L Leech. 2006. Linking Research Questions to Mixed Methods Data Analysis Procedures 1. The Qualitative Report, 11, 3, 474-498. Retrieved from https://nsuworks.nova.edu/tqr/vol11/iss3/3

[35]   John W. Creswell. 2014. Research design: qualitative, quantitative, and mixed methods approaches. University of Nebraska. Nebraska.

[36]   John W. Creswell. 2003. A framework for desing. Research design Qualitative, Quantitative and Mixed Methods Approaches, 3-26. University of Nebraska, Lincoln.. Retrieved from: http://isites.harvard.edu/fs/docs/icb.topic1334586.files/2003_Creswell_A%20Framework%20for%20Design.pdf

[37]   Jinny Cascante. 2011. Métodos mixtos de investigación: Guía de estudio. Universidad Estatal a Distancia de Costa Rica. http://repositorio.uned.ac.cr/reuned/handle/120809/390

[38]   Tiberius Ignat & Paul Ayris. 2020. Built to last! Embedding open science principles and practice into European universities", Insights, 33: 9, 1–19; DOI: https://doi.org/10.1629/uksg.501

[39]   UNESCO. 2019. Towards a UNESCO Recommendation on Open Science. Building a global consensus on Open Science. [Brochure] Available at: https://en.unesco.org/sites/default/files/open_science_brochure_en.pdf

[40]   Francisco José García-Peñalvo. 2014. Formación en la sociedad del conocimiento, un programa de doctorado con una perspective interdisciplinar. Education in the Knowledge Society, 15(1), 4-9. Retrieved from: https://revistas.usal.es/index.php/eks/article/view/11641

[41]   Francisco José García-Peñalvo. 2013. Education in knowledge society: A new PhD programme approach. In Proceedings of the First International Conference on Technological Ecosystems for Enhancing Multiculturality (TEEM'13) (Salamanca, Spain, November 14-15, 2013), F.J. García-Peñalvo Ed. ACM, New York, NY, USA, 575-577. DOI:10.1145/2536536.2536624.

[42]   ÁLLEÁ. All European Academies. 2017.The Eropean Code of Conduct for Research Integrity. Revised edition. Berlín. Available at: https://www.allea.org/wp-content/uploads/2017/05/ALLEA-European-Code-of-Conduct-for-Research-Integrity-2017.pdf