

# Cooperative Learning Web Application for Water Care in Colombia

## *Manglar*: Actor-Network Theory Software Solution

<https://doi.org/10.3991/ijet.v12i04.6733>

Pedro Guillermo Feijóo García  
Universidad El Bosque, Bogotá D.C., Colombia  
pfeijoo@unbosque.edu.co

Deiby Fabián Medina Cortés  
Universidad El Bosque, Bogotá D.C., Colombia  
dmedinac@unbosque.edu.co

Maria Catalina Ramírez Cajiao  
Universidad de los Andes, Bogotá D.C., Colombia  
mariaram@uniandes.edu.co

Edier Ernesto Espinosa Díaz  
Universidad de los Andes, Bogotá D.C., Colombia  
ee.espinosa10@uniandes.edu.co

**Abstract**—One of the major challenges related to water care in Colombia, is to teach and massify good practices along its territory and population, looking forward to promote the preservation of this valuable resource. This paper presents details corresponding to the design, development and implementation of the Web Application *Manglar*, born within the project *Liga del Agua*, proposed for cooperative learning towards water care in the department of Cundinamarca, Colombia. The designed Application uses a graph approach, focused on actors and relations, exposing how the participant organizations and communities cooperate, share resources and interact, letting any user to know what has been elaborated and constructed throughout the project *Liga del Agua*. In this document, we focus on the architecture corresponding to the designed Application, exposing the requirements and functionalities, developed and implemented, looking forward to guarantee a technological scenario for cooperative learning within this context.

**Keywords**—Water care, cooperative learning, learning technologies

## 1 Introduction

Colombia is a country characterized by the richness of its nature, being renown when it comes to hydrographic sources. As a nation, it has coastlines on the Atlantic

and Pacific Oceans, possessing along its territory rivers, lakes and hydric fountains that supply its population from north to south. Consequently, treatment and education on water resources care, has become a priority in government plans and projects, considering water as a source of energy, life and health for each Colombian.

Even with the importance of taking care of this valuable resource, there are several Departments, such as the Department of Cundinamarca, which are subject to contamination due to various factors arising from formal and informal agriculture, illegal industry and also from the citizenship. This, led to the proposal and undertaking of the *Liga del Agua* project, impulsed by the *Gobernación de Cundinamarca*, which promotes the generation of learning resources on water care in municipalities and communities of the Department. Through innovative ideas in schools, we sought for the generation of knowledge around the care of this resource, aiming to promote good practices towards the participating communities.

*Manglar* is born as a technological tool designed to facilitate communication and interaction between participating organizations and communities, looking for the promotion of collaborative learning around practices generated around water care. Its design aims to be intuitive for the citizens involved, offering appropriate graphic mechanisms to understand the collaborative network, founded by organizations, relations and resources, constituted within the framework of the *Liga del Agua* project. This paper presents details corresponding to the design, development and implementation of the Application *Manglar*, describing its architecture, its requirements and functionalities incorporated, pretending to guarantee a technological scenario for cooperative learning in water care for the participant communities.

This document is organized as follows: Section 2 presents some previous works, concepts of interest, and existing tools similar to the designed Application. Section 3 presents the problem addressed in this study, the purpose for undertaking this project and the obtained solution after it. The final part of this paper presents the study's conclusions and a proposal for future research related to this project.

## 2 State of The Art

### 2.1 Related Studies

Cuellar-Padilla et al., as stated in [1], performed a study that linked science with people, focusing on solving a specific problem with Andalusia's agriculture community (Andalusia, Spain). Throughout their work, they proposed a methodology for the implementation of participatory action research in rural areas, obtaining significant results around finding solutions collectively through social constructivism between researchers, technicians, producers and consumers. The authors examined the methods applied, and provided a reflexive analysis on them. Conclusions of this study indicate positive results accord to the contributions that agroecology and PAR (Participatory Action Research) processes can make to sustainable and innovative research proposals.

García Abad & Barreto Ávila, as it is indicated in [2], present the results obtained with rural Peruvian communities, after measuring the impact of IT (Information Technologies) appropriation, specifically of mobile technologies and internet. The authors concluded that, even if the rural habitants possess significant limitation towards new technology trends, the use of IT showed to be useful for the creation of new scenarios of interaction, offering new possibilities towards education and social context improvement.

Murphy & Terry, as described in [3], present results corresponding to a study, using the Delphi Method, oriented to develop consensus and proposals on future research activities concerning technological adoption for instructional use in agricultural educational settings. This study concludes that the use of electronic communication, information, and imaging technologies, will improve learning according to the agricultural education context. Furthermore, they recommend the design and provision of distance education technologies, to strengthen and improve agricultural education settings.

## 2.2 Actor-Network Theory (ANT) and Constructivism

The Actor-Network Theory (ANT), as explained in [4], invites to consider symmetrically as actors both the human being and any "non-human" object, within the context of study or interest. Under this theory, and as Latour indicates, it is considered that an Actor-Network is not the same, much less reducible, simply to an actor nor a network. It is indicated that the Actor-Network is itself an actor that interweaves elements or heterogeneous objects in the same context, allowing in itself a dynamic network with the capacity to redefine as a whole, or any of its composing parts.

An interesting example to introduce and exemplify this theory is how Nieto, through Ref. [5], presents the role of navigational artifacts, interrelated with religious beliefs and human participants, in the context of the Spanish conquest of America, seeking to understand those practices that arose methodologies and scientific knowledge to assert Spanish control of the Western world. Although the context was intended to focus on human actors, Nieto makes it evident that it is impossible to explain Atlantic history and control over the New World without the important intervention and action of those non-human elements involved: navigation artifacts, nature, Faith, among others. He also explains how it is possible to modify the network of relations between historical and technical actors, thus generating infinite possibilities for contextual interpretation.

For the purpose of *Liga del Agua*, this theory plays a fundamental role for the understanding of the Actor-Network composed throughout its development. Not only the actor is generalized symmetrically between the individual, the community and the organization, but also it is given importance to the generation of resources by them and the respective cooperation (relationships) throughout their interaction. Using a Non-Directed and Non-Valued Graph (arcs with no direction nor weight) or Valued (without weight in its arches, as it is indicated in [6]), as representative data structure, this theory is landed technologically with *Manglar*, offering interactivity mechanisms that ease the contextual observation of the Actor-Network, while providing a dynamic

scenario of change according to the communities and stakeholders involved in *Liga del Agua* project.

In addition, as it is explained in Ref. [7], the Constructivist Theory is presented as an educational paradigm articulated within this project. This theory fits perfectly with TAS, because it focuses on understanding the learning subject or, in other words, the human actor involved in the learning context. The primary characteristic of this educational paradigm is to understand how the participation of the subject in the context, generates learning mechanisms through the assimilation of experiences and the understanding of the environment that surrounds him or her. It is the subject who designs and defines the structure of what he will identify as "knowledge", based on the experiences and information provided by his environment.

Evolving the paradigm, a social constructivist approach is constituted by articulating information technologies for the massification of the Actor-Network that constitutes the *Liga del Agua* project. The particular environments, lived in each participant community, are globalized through *Manglar*, allowing each individual involved to access the network as a whole, as well as any specific actor or cooperation. By providing technological interaction tools, *Manglar* offers a rich, constructivist, online learning scenario, articulating a scheme that responds to what an Actor-Network is, cooperating and transmitting educational and informational resources of interest.

### 2.3 Similar Technologies

Similar technological solutions are presented below:

1. *Redeshistoria*, as it is indicated in [8], is a Web tool with the objective to support the development of the historical thinking of students, based on the Actor-Network Theory (TAS). The application allows the student to have a vision of a historical moment through a set of actors grouped into five categories: Humans, divinities, artifacts, institutions and nature, where each actor has a definition, a descriptive text, images that represent it, and documents of primary sources on that actor.
2. *RoBlock*, as it is described in [9], is a Web Application that offers virtual and remote mobile robotics scenarios for programming and algorithms autodidactic learning, using visual blocks programming as a non-syntactical ludic mechanism. The application incorporates and exhibits a constructivist canvas, offering the student different levels to learn, by himself, each of the concepts of interest: variables, sensors, conditionals, cycles and functions.
3. *NetLogo*, as it is explained in [10], is a language and platform designed for Multi-Agent Systems (MAS) modeling. It provides generic mechanisms for Actor-Networks simulations, being useful and applied in multiple and different contexts.

## 3 *Manglar*: Problem, Purpose and Design

The *Liga del Agua* project had the participation of 11 schools from eight municipalities constituted in the Guavio region, within the Department of Cundinamarca. Throughout this region, it is produced approximately 70% of the water consumed by

the city of Bogota (the capital city of the country, with about 10 million inhabitants), and 20% of the energy of the Colombian national territory (see Ref. [11]). Each school carried out the creation and design of innovative and educational resources, with the purpose of generating good practices towards water care, thus promoting the preservation of this valuable resource.

The problem to be solved with *Manglar* arises from the lack of effective interaction that exists today among the participating communities. Each community, as an actor in the constituted Actor-Network, provides valuable information of the innovation and learning process conducted, which is explicitly limited by the lack of communication and interaction with other communities and stakeholders. The ignorance of what has been done in other locations, does not promote an effective evolution in the generation of resources related to water care practices. Furthermore, it promotes a rich scenario for the generation of IT solutions that favor cooperative learning and social constructivism.

By offering technological mechanisms for interactive access and effective graphical visualization of resources, *Manglar* guarantees a global knowledge scenario of the constituted Actor-Network, thus offering the possibility of collectivizing the learning process carried out throughout the *Liga del Agua* project, guaranteeing both educational cooperation and social constructivism.

The solution was designed with a Model-View-Controller (MVC) architecture pattern, as it is shown in Figure 1, complementing it with Object-Relational Mapping (ORM) technologies for Database access and management. As it can be seen, the architecture is composed of a variety of components, each of them responding to specific functionalities, deployed according to its responsibilities.

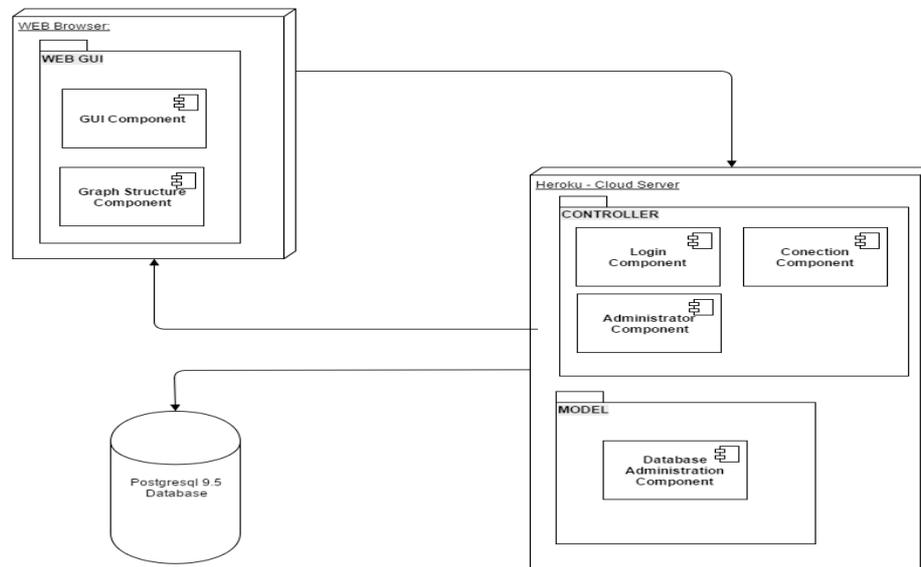


Fig. 1. Package & Deployment Diagram

*Manglar* has a total of four logical entities (Organization, Cooperation, and Resources by Organization and Cooperation), each of them responding to one of the corresponding elements of the Actor-Network composed through *Liga del Agua* project. Every entity exposes a unique ID and relations to other entities that are expressed as *keys* within the Database. A total of 10 functionalities were developed, offering different views and access for two user profiles: administrator and general user. As it is shown in Figure 2, both types of users have visualization permissions, being the administrator the only user profile able to modify and add information to the Actor-Network.

After conducting the development and implementation phases, we obtained a robust Web Application that includes the corresponding functionalities indicated in Figure 2, responding to the software architecture illustrated in Figure 1. As it can be seen in Figure 3, the Graph displays the constituted Actor-Network along the *Liga del Agua* project, letting the user access information of every actor and every relation. Resources are available as PDF documents, YouTube videos and JPG/PNG images.

As a Web Application, *Manglar* offers friendly and interactive graphical mechanisms, to let each and every member of the participant communities know about the learning process conducted, and all of the resources developed, by any existing participant organization within the project.

*Manglar* was presented and approved by the Gobernación de Cundinamarca, as a functional prototype System for the *Liga del Agua* project. Presentation that exhibited and demonstrated each functionality described in the User Case Diagram illustrated in Figure 2.

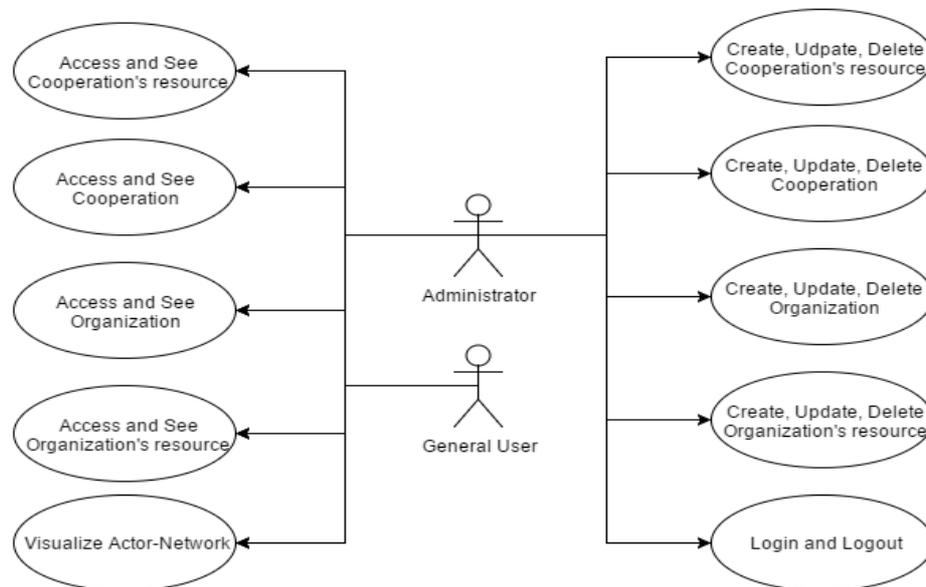


Fig. 2. User Case Diagram

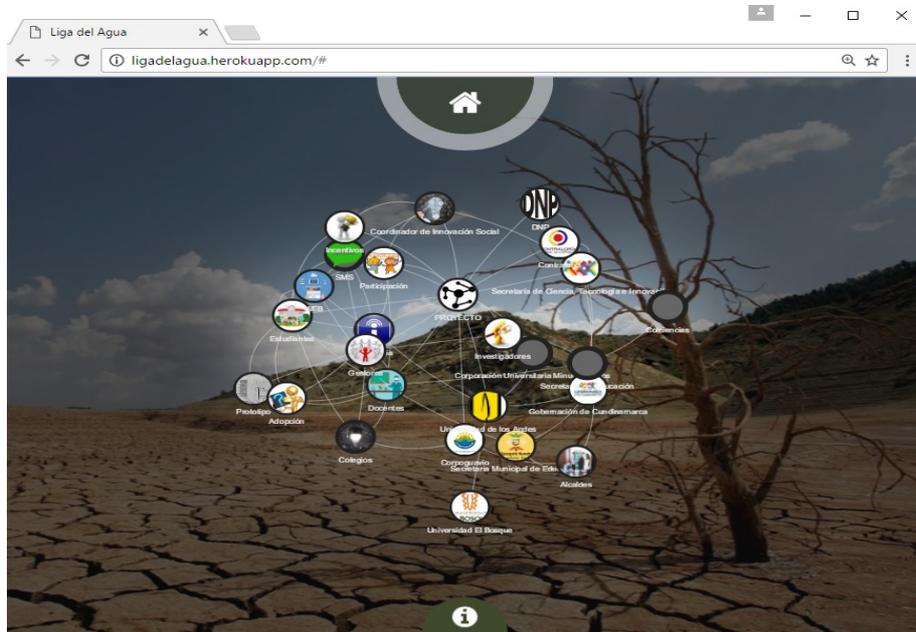


Fig. 3. Actor-Network of *Liga del Agua*

#### 4 Conclusions and Future Work

Having completed this pilot, we can conclude that *Manglar* responds satisfactorily, according to the criteria of the stakeholders involved, to the problem presented in the *Liga del Agua* project. This is an application that evidences an active inclusion towards the Actor-Network Theory (TAS), through the offer of graphic and interactive mechanisms that provide a user-friendly experience. Likewise, we conclude that the elaborated Application offers a rich information scenario, which invites communities to collaborate, interact and learn collaboratively.

As future work, we recommend extending the project in two fronts: technology and methodology. Technologically, *Manglar* can be extended to mobile devices, allowing the citizen to interact from his/her cellphone or tablet with the Actor-Network. Methodologically, this pilot can be used to evaluate the educational and social impact of the tool in the communities. The latter, with the purpose of pivoting it and extending it to new functionalities.

#### 5 Acknowledgment

This project, on which this paper reports the conception, design and results corresponding to *Manglar*, was thanks to the cooperation agreement between *Universidad El Bosque* and *Universidad de los Andes*, for the project: “*Strengthening of Water*

*Resources Community Management, through the Reduction of Water Consumption, using Participatory Techniques-TP and Information and Communication Technologies (ICTs) - Cundinamarca Centro Oriente*” (recognized by the participant community as *La Liga del Agua*). The authors express their gratitude to the *Secretaría de Ciencia, Tecnología y Educación* of the *Gobernación de Cundinamarca* for the coordination of this project, to the *Sistema General de Regalías* of Colombia, for financing it, under the agreement SCTel 022 of 2014 signed by the *Gobernación de Cundinamarca*, *Universidad de los Andes* and *Corporación Universitaria Minuto de Dios*. In addition, the authors thank the students, teachers and managers of the participating communities.

## 6 References

- [1] Cuéllar-Padilla, M., & Calle-Collado, Á. (2011). Can we find solutions with people? Participatory action research with small organic producers in Andalusia. *Journal of Rural Studies*, 27(4), 372-383. <https://doi.org/10.1016/j.jrurstud.2011.08.004>
- [2] Abad, A., & Ávila, M. (2014). El uso, apropiación e impacto de las TIC por las mujeres rurales jóvenes en el Perú. *Revista de Estudios para el Desarrollo Social de la Comunicación*, 251-269. <https://doi.org/10.15213/redes.n9.p251>
- [3] Murphy, T. H., & Terry, J. H. (1998). Opportunities And Obstacles For Distance Education In Agricultural Education. *Journal of Agricultural Education*, 39(1), 28-36. <https://doi.org/10.5032/jae.1998.01028>
- [4] Latour, B. (1987). *Science in action: how to follow scientists and engineers through society*. Cambridge, MA: Harvard University Press, p344.
- [5] Olarte, M. N. (2013). *Las máquinas del imperio y el reino de Dios: reflexiones sobre ciencia, tecnología y religión en el mundo atlántico del siglo XVI*. Bogotá, D.C., Colombia: Universidad de los Andes, Facultad de Ciencias Sociales, Departamento de Historia, 1 – 18.
- [6] Aguilar, L. J., & Zahonero, I. (2013). *Estructuras de datos en Java*. Madrid: McGraw Hill, p432.
- [7] Galvis, A. (2013). Teorías de aprendizaje como sustento a la creación de AVAs. In *Tercer Seminario de Formación Docente*. Tercer Seminario de Formación Docente, Universidad Nacional de Colombia, Bogotá D.C., Colombia.
- [8] Nieto, M. (2016). Un ambiente virtual para la reflexión histórica. *Innovate 330 - Investigando la innovación con TIC en Educación*, Universidad de los Andes, Bogotá D.C., Colombia, 478-483.
- [9] Feijóo, P. G., & Rosa, F. D. (2016). RoBlock – Web App for Programming Learning. *International Journal of Emerging Technologies in Learning (IJET)*, 11(12), 45. <https://doi.org/10.3991/ijet.v11i12.6004>
- [10] Caillou, P., Coyrehourq, S. R., Marilleau, N., & Banos, A. (2017). Exploring Complex Models in NetLogo. *Agent-Based Spatial Simulation with Netlogo*, Volume 2, 173-208. <https://doi.org/10.1016/B978-1-78548-157-4.50006-6>
- [11] Acero López, A. E., & Ramírez Cajiao, M. C. (2015). *La investigación-acción participativa como metodología de proyectos tecnológicos Caso: Proyecto “Gestión del recurso hídrico”*. (Thesis (Magister en Ingeniería Industrial). Universidad de los Andes). Bogotá: Uniandes.

## 7 Authors

**Pedro Guillermo Feijóo García** is a *Core Faculty* Assistant Professor and researcher at Universidad El Bosque, Colombia (pfeijoo@unbosque.edu.co).

**Deiby Fabián Medina Cortés** is a research assistant of OSIRIS&BIOAXIS group at Universidad El Bosque, Colombia (dmedinac@unbosque.edu.co).

**Maria Catalina Ramírez Cajiao** is an Associate Professor and chief of *Ingenieros Sin Fronteras* at Universidad de los Andes, Colombia (mariaram@uniandes.edu.co).

**Edier Ernesto Espinosa Díaz** is a graduate assistant for *Ingenieros Sin Fronteras* at Universidad de los Andes, Colombia. (ee.espinosa10@uniandes.edu.co).

Article submitted 06 February 2017. Published as resubmitted by the authors 18 March 2017.