PARTICIPATORY ACTION RESEARCH AS A METHODOLOGY FOR THE DEVELOPMENT OF APPROPRIATE TECHNOLOGIES BY COMMUNITIES

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ABSTRACT

The social and environmental development potential of countries like Colombia shows the need to articulate right from the communities, the processes and projects relevant to their territories. Furthermore when vital aspects of human health, such as access to clean water and water consumption, are also opportunities for the development of innovative technological solutions, stemming from the relationship between society and natural systems. In this context, a group of researchers together with a community of about 1,500 children and 15 teachers from schools of several towns in Cundinamarca department (Colombia) has been developing a technological platform founded on the community-based action research proposal of Ernest Stringer. This interactive technological platform, based on the use of SMS and the web, is called "La Liga del Agua". It is a jointly constructed space where synergies between the different stakeholders around the proper use of water resources can arise, based on the self-recognition of wastewater problems on each of the participants' homes. Thus, the problem approaches from the daily practices and the technological inefficiency, generating an empowerment of the water importance. The main theoretical foundation of this technological co-construction is based on the spirit of participatory and democratic systemic intervention, from the soft systems methodology of Peter Checkland, as well as the sociocultural vision of the community that, voluntarily, intend to solve a problem collectively, as suggested by Rusell Ackoff. In this article, we will show the jointly design process of "La Liga del Agua" platform and the incidence on the increase of the good practices of water resources usage. In addition, the results of the teaching strategies and recreational activities that seek to increase the empowerment by the actors and their interaction with the technology will be presented. To conclude, all the learnings of the proposal will be introduced, so it can be replicated on other contexts with environmental concerns.

Keywords: Action Research; Technology Design; Participation; Learning Communities.

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PROBLEMS SUGGESTED

In recent years, information technologies and communications have been a crucial component in the development of every country, both for first-world countries (Pérez Serrano & Sarrate Capdevila, 2011) and third-world countries (Dutta & Das, 2011). Currently, given globalization conditions and science and engineering progress in high-innovation environments have imposed on society, developing these aspects on day-to-day life has become a need not only for governments and educational institutions but for communities under vulnerability conditions (Pérez Serrano & Sarrate Capdevila, 2011).

Colombia, since 2008, has driven scientific nature organizational construction through Science, Technology, and Innovation (STI) policies as a normative tool to give life and autonomy to institutions like Colciencias (Congreso de Colombia, 2009) or to Science, Technology, and Innovation National System that would manage the resources of the General System of Royalties for those effects (Congreso de la Republica, 2011). Even with this, lack of long-term policies that promote organization, planning, and continuity of actions aimed to the generation of a STI environment has led researchers, research groups, and public and private institutions to struggle differently to generate short-term results in order to be able to have first-tier research in the country.

To understand it, it becomes necessary to look at the different dimensions STI efforts have been formulated in Colombia:

- It is necessary to recognize the close relation STI has with the educational system.
- Lack of articulation between the productive sector and base communities that tend to STI product democratization is evident (Botero & Rodríguez, 2009).
- It is also noticeable that although state funding processes have been secured, the increase of investments in terms of GDP fluctuations with clear, constant, and consistent sources generates concerns to the Colombian State, particularly to executing entities.
- However, the most important one is the vision to base research on in order to generate an adequate orientation to the relevant actors' interest. Who is these policies' final client?

The issue lies in the lack of strategies that support the development of these policies. Although it is very common to find tools that allow looking at technology management from the perspective the community is involved in (Certomà, Corsini, & Rizzi, 2014; Layton Edwin T., 1974; Pick & Azari, 2011) or from the perspective technology interaction allows it to evolve (Douthwaite, Keatinge, & Park, 2002), change (Al Lily, 2013; Dutta & Das, 2011; Reyes, n.d.), and adapt to environmental conditions (Dutta & Das, 2011; Kivunike, Ekenberg, Danielson, & Tusubira, 2011; Kyem, 2012; Samah, Shaffril, Hassan, & D'Silva, 2011; Tiwari, 2008); scientific literature has a wide gap and has not generated integrated models that allow generated, built, or researched scientific and technological tools may be harmonically carried out when connected to society.

SYSTEMIC APPROACH

The challenge is to communicate the research world and the life world, to achieve integration between the academy and the life world, as set out in the past by Orlando Fals Borda (1987) since action research is, perhaps, one of the most vital challenges. Dialogue among knowledgeable parties is a challenge that implies building a more off-center dialogue, to promote communication, and to join efforts to generate capacity to produce and appropriate knowledge among southern countries and their interlocution with northern countries on equal basis (Higinio, Díaz Pompa, & Lautín Lupeztegui, 2011). It entails understanding not only societal dynamics and its relation with technology and innovation but it forces us to think from a systemic point of view on the situation underlying structures.

Soft Systems to Design Solutions

The thought on soft systems arises as an alternative for situations that do not have clear system and issue modeling, which is usually unstructured, to give them a participative, active, and inclusive solution (Checkland & Tsouvalis, 1997). It implies it should be framed within a research-action mode where the observer or researcher must have direct engagement in the issue based on the experience given as result, reflection, and learning of the system itself (Checkland, 1995). These aspects, relevant and necessary to get to the core of problematic issues, forces us to reflect on:

- The intervention: Must think not only about the system design issues, but must consider underlying difficulties to take it into reality and to conclude its implementation (Christis, 2005). The main difficulty to be considered is that solutions are insufficient or even useless if actors are not willing to carry them out.
- The systemic: We take the problematic situation into a global context and not as individual parts, just as it is done by the systemic thought. This characteristic allows us, additionally, taking into account arising properties generated from the system inner dynamics.
- The participative dimension: Those involved in the situation are the ones, who know how the system operates, because they are deep into it, implying people are called to make decisions. People and their vision on the problematic are the ones who determine the characteristics of the system, is what may turn a situation into a difficulty for some people but not for others. In addition to it, these same visions of the world people have are highly restricted because they are the ones that define the system.
- Learning processes: We are facing soft systems, with many actors that have diverse visions of the world and different goals, which makes not possible to achieve everyone's goals and optimizing a solution (Bjerke, 2008). Involved parties must generate learning processes, particularly on what has to do with the situation and with the perceptions other actors have on the situation.

Idealized but Possible Designs

Achieving technically and socially feasible solutions imply designer hard work once he/she understands the solution. As set out by Rusell Ackoff (2001), a technical solution design implies the disappearance of something present that is unwanted or the creation of something inexistent. But the conditions for it to be carried out are not a few (Camila & Rojas, n.d.). Some of the most relevant aspects shall always be:

- The system and its ideal state must be flexible, susceptible to change, and easy to be continuously improved.
- An idealized design is not utopic because it is susceptible to be improved. It is based on the recognition that an idealized design may not be so for long. Therefore, the product of an idealized design is not an idea state or system but a state or system seeking an ideal (Asaro, 1999).
- For the design, designers do not have to pretend they have all the answers that might arise about the ideal. Design must be made seeking a state where it is possible to find the answers that are not there yet. Thus, design is subject to a continuous review in the light of information, knowledge, understanding, judgement, and imagination recently gained.
- The main obstacle between a person and his/her desired future is himself/herself (Milovanovic, 2003). Design is a way to turn possible what seems impossible.
- It enables the participation of those that seem potentially affected by it. Design process does not require special skills (everyone may participate) and allows participants to be aware and express their type preferences and idea (Milovanovic, 2003)s.

Participatory Action, the Integrating Dimension

Since the last decades of the 20th Century, the social science research field, particularly psychology, education, and engineering, has been having great changes that set significant differences in ontological, epistemological, ethical, and methodological dimensions to approach the study object. Until mid-twentieth century, social impact research was strictly framed into a quantitative focus led by natural sciences or hard sciences, positivist, with coherent characteristics with the subject-object relation, experimentation, objectivity, proof, validity, and reliability as indispensable conditions (Colmenares E., 2011). But, when setting out a response other than positivism from this research methodology, new ways to know this reality were set out with the intention to place and guide practical interest in a socio-critical way framed into am emancipatory or liberating process to unveil and break in a transforming dialectic way the research paradigm (Lleras, 1996).

Participatory action research is a methodology that presents research processes as an integrating activity that combines social research, work, and action. Its fundamental purpose is based on producing knowledge and aware changes on the subjects' day-to-day reality joined to the collective learning. Different than the intricate routines of traditional scientific research where technical language and complex statistical procedures prevail, it must be presented summarized and understandable (Stringer, 1999). This author proposes

thinking about three processes – Look, Think, and Act – to allow seeing research from a simple framework that grows in detail as activity complexity increases. Additionally, it must be seen as a continuously recirculating process on activities. This PAR process looks at research from four different perspectives, as set out by Fals-borda (1987):

- Collective research to seek teamwork including internal and external researchers and the community in information search, detection, classification, and problem solution.
- The critical recovery of history though lore recovering elements that may be useful to analyze issues and possible solutions.
- Assessment and use of lore that help achieving superior mobilizing results because they take into account essential regional values; that is, elements that are culturally identifiable.
- Production and diffusion of new knowledge.

METHODOLOGY APPLICATION

The study case proposed by the authors is a "Strengthening of water resource community management through consumption reduction using participative techniques and information and communication technologies, Cundinamarca, Eastern Central" project, developed with Cundinamarca Governor's Office, Universidad de Los Andes, Corporación Universitaria Minuto de Dios, Parque Científico de Innovación Social, Ingenieros Sin Fronteras Colombia (ISF-COL), Inalambria Internacional y Corpoguavio. The general objective of this process is: "Strengthen the capacities to manage the water resource in some towns in Guavio and Sabana Centro provinces, under Social Appropriation of Innovation" (Universidad de Los Andes & Corporación Universitaria Minuto de Dios, 2014).

From the experience of the formulators in the development of projects in the provinces (Guavio y Sabana Centro), it has been possible to determine that most people are not aware of these problematics or perceive them as distant to their closest environment. El Guavio province, Cundinamarca that encompasses Guasca, Gachetá, Ubalá, Gachalá, Junín, Guatavita, La Calera, and Gama towns (Universidad del Rosario, 2009) is a region characterized by natural resources and a diversity of climate areas; it has hydric tributaries and paramos. This territory provides 80% of water consumed in Bogota and 20% of the country's energy. (Cámara de Comercio de Bogotá & CEPEC, 2009).

The perception of water resource wealth among the population in the region makes such people perceive the resource as unlimited and they do not seem to care for it. The "Water resource management" project seeks to generate water saving dynamics among participating students in 9 towns (Guasca, La Calera, Gachetá, Junín, Gachalá, Ubalá, Guatavita, Sopó, and Zipaquirá)

For that, they have three main strategies:

- The generation of water-saving dynamics, which are carried out measuring student direct consumption through their water meters and indirect measures for those who lack a meter.
- The development of technological prototypes for the efficient management of water resources, which are developed by participative construction of participating students.
- The development of knowledge, techniques, and strategies for students to generate best water saving practices. For that, the technological platform "La liga del agua" (http://laligadelagua.com/) was developed.

Given the project progress and needs, participating researchers indicate their greatest concern is focused on achieving the project sustainability through:

- Getting relevant actor participation to generate social project appropriation.
- Empower students with tools to adequately manage the water resource.
- Problems associated to water resource efficient use, to technology, management and appropriation in classrooms, and to properly teaching it were detected.
- Finally, relevant actors for the adequate development of the project were identified.

Information and Communication Technology in the Student Empowering Process: Liga del Agua Platform

The Conceptualization of Liga del Agua Platform and Student Participation:

Project recognition by the community.

The implementation of the project work under the following scenarios:

1. Selected educational institutions directors' interest.
   In the first meeting with educational institutions, the project was presented with the objectives attempted. The institutions stated their interest to actively participate supporting the process, which is essential to motivate participating students.
2. Project presentation to different local actors
   In this process, different actors such as Mayor's Offices, Government Secretariats, and Corpoguavio environmental authority were approached
3. Initial approach to the academic body of the educational institutions.
   After the formal presentation and educational institution directors' approval, one or more teachers we appointed to accompany the project and who became a fundamental part since they are the ones who introduce the project to students.
   One of the characteristics found was the appointed teachers' autonomy. They decide factors such as time, space, and internal and specific strategies at each school. According to what we have already described, dialogue would be

fundamental for the success or failure in the intervention of students at each school; this is where an acceptance process starts with the teacher wanting to become a collaborating party for the process.

4. Empowering the students.
   The initial strategy was to define how the students would become part of the project and the required participating process.

Students had to fulfill a baseline that gave us an initial recognition of how the platform design process would go. The most important issues to take into account for student participation were:

1. Most of the students had to have a mobile to be able to register them in the technological platform.
2. Student internet access at home or school.
3. The percentage of students who had a water meter at home.

One of the issues faced was internet access in the towns where the project was going to take place, because it was a fundamental requirement to develop it. When the towns were selected, it was thought school had internet access but once an initial visit to them was made, most of them lacked that service. Thus, to start participation, mobiles were registered for students to text their water consumption.

Additionally, not every student had a water meter; a strategy for these students to report their consumption had to be designed. This strategy was to measure approximate water consumption through volumes and times.

Finally, after these setbacks were overcame, the design of the technological platform started with students participating through trivia strategies. Every time a student reported water consumption, they had to compete guessing water-resource related riddles; therefore, motivation was achieved through water resource learning and awareness.

Platform Design and Result

Interacting with a flexible technological platform, students participated becoming “heroes” to keep water resources. The flexibility set forth by Ackoff model is that it had to have change dynamics adapting to specific realities. This is how it was possible to integrate motivation and design strategies to get the expected students’ participations.

The design of the platform followed the design process according to stages defined by Checkland for its development from Inalambria designers’ imaginary on the platform, testing it, and readapting it according to the processes once it was taken into the real context found.

Participation Techniques to Achieve the Project Objective

Prototype Joint Construction to Help Water Saving

For the work design process with the students and teachers was, again considered, the participation in knowledge joint construction activities where the team leader seeks issue initiatives and solutions from the community.

The activities that have been developed within the project have the participation of the research team, teachers, students, and other strategic stakeholders. They include:

Dry Toilet Construction

The rural context where most participating students live requires awareness of technologies that are easily applicable in their environment and that is why initially the dry toilet was chosen. A dry toilet is a technological option that may be easily adopted anywhere, because it does not require a water source to flush it. In these toilets, liquid matter is separated from solid matter generating a feces-composting process, which becomes useful as fertilizer; urine becomes useful as a bio-fertilizer. Thus, waste is used keeping it from becoming a pollution load for the environment (Flórez, 2016).

To set up the prototype, some participating students and teachers helped building it once they knew its advantages; thus, they were now empowered to build one in their own homes.

Action Co-Design Laboratory: Green and Sustainable Technology

This exercise carried out twice, involved college students' joint participation with school participating teachers and students. The exercise was to gather a number of work groups of event participants, lay out real issues to them, and have them look for solutions and assess them.

In this process and in the search for active student participation, they had to submit proposals and assessments. It required college students to empower them and to make them participate in the process.

Educational Institution Student Technological Ideal Preparation

The challenge was to have students and teachers in groups to develop device ideas to help reduce water consumption in their homes.

During the six-month period, students had to report progress on their ideas and schemes; then, through an assessment conducted by the research team, the best ones were selected from each school, with recommended improvements, and they were presented in a public event at the universities. It helped students to be empowered with science, technology, and innovation processes though participation and understanding innovation generating possibilities.

Conclusions:

1. Knowledge creation and diffusion must be though from a perspective where system member interaction with technology is harmonic.
2. Action-research elements are transverse to systemic thought given that both highlight elements that democracy and participation have for the solution of any problem situation.
3. Design processes imply total understanding of the need the process or product must supply; therefore, including communities in the construction of solutions allows improving obtained results.
4. Process continuous participation and assessment helps adapting solutions into required contexts.
5. Action-research methodologies applied to the project have given empowering community results.

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