An Interactive Learning Space for Technological Innovation in Rural Cusco, Peru

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Abstract

One strategy of the university as a knowledge-creating institution to strengthen its relationship with society is through technological innovation to meet different necessities in rural communities of the highlands of Peru. Even though many of the initiatives that deliver technology from the academia to the rural sector have worked under the approach of technology transfer which is a methodology that has limitations in generating community engagement, they can also create an appropriate scenario to foster mechanisms of an interactive participation between the actors involved. This paper will discuss why an environmental-friendly housing model built in a rural community in Cusco, Peru named Ecological Home for the Andes (EHA) which represents an example of an interactive learning space for technological innovation, is an opportunity for community empowerment in the foreseeable future. First, it will be described the intervention supported by different strategies like multidisciplinary research, technology development and dissemination and international service learning in engineering. Then, it will be analysed the impact and lessons learned of this initiative under the concept of social learning to finally demonstrate that interactive learning spaces such as the EHA can provide more understanding about the relationship between technology and social inclusion, allowing to reflect on its strategic importance to address poverty in the Andean rural sector of Peru.

Keywords: interactive learning spaces, social learning, ecological housing, technological innovation.

Introduction

One of the characteristics of the Peruvian population is its increasing urbanization, 65.0% resides in urban areas and only 35.0% in the rural area. While the rural population represents only slightly more than one third of the total population, 60.5 per cent of the poor in the country is concentrated in rural areas (INEI, 2010). According to Roca Rey & Rojas (2002), not only poverty is focused in rural areas, but also they have the highest exclusion rates nationwide, making the poor and also excluded population extremely vulnerable to the extent that may be trapped in poverty and transmit it to future generations. In the case of the rural Andean, its vulnerability is due to a diverse number of factors such as underemployment, malnutrition, illiteracy, low quality of education and health care services, precarious housing, lack of infrastructure services, among others. Those conditions make rural population of the Andes complete or partial excluded from participation in society.

Therefore, if the concept of social exclusion (Gacitúa et.al., 2000) is a multidimensional process that involved a set of factors, contributing to the generation of poverty and social inequality, social inclusion, then, is defined by the institutional mechanisms and processes that ensure that all sectors of society have the same opportunities for integration into economic, political, gender, ethnic and environmental aspects. In this sense, as INEI (2012) states, social inclusion not only refers to the minimum levels of integration for belonging to a particular community, but precisely to the quality or intensity of that membership that can ensure an adequate quality of life.

On the other hand, Thomas and Fressoli (2007) argue that technologies play a central role in processes of social change since demarcate positions and behaviours of the actors, condition structures of social distribution, costs of production, access to goods and services and generate, facilitate or hinder the resolution of social and environmental problems.

For this reason, resolving the problems of poverty, exclusion and underdevelopment cannot be analysed without taking into account the technological dimension in production of food, housing, transportation, energy, access to knowledge and cultural heritage, environment, social organization, etc. Hence, the universities as producers of knowledge and technologies have the capacity to contribute in reducing social exclusion and poverty through different technological innovation initiatives to meet different necessities in vulnerable social groups.

In the context of universities as agents for social change, in 2007 Grupo de Apoyo al Sector Rural at the Pontificia Universidad Católica del Perú (GRUPO PUCP) and Rensselaer Polytechnic Institute (RPI) started a project together named Ecological Home for the Andes (EHA) in the district of Langui at 3,969 meter above the sea level which is located in the province of Canas in the region of Cusco. This is a healthy and environmental-friendly housing model where students and professors from both universities can design, develop and implement innovative, economic and replicable technologies related to energy, water, health and housing in order to disseminate them to local families.

The innovative aspect of this initiative is not only because of the technologies implemented in the EAH, but also for the synergy of the different strategies put on practice like multidisciplinary research, technology development and dissemination, and international service learning in engineering; that make it an example of an interactive learning space. Arocena and Sutz (2002) cited in GLOBELICS (2012, p.43), define it as "a relatively stable situation in which actors have opportunity to learn while interacting with other actors in search for useful knowledge to address a given problem". Although this initiative was not conceived under the approach of social learning (Adur Sar, 2012) in the technology generation and adoption processes which purpose is to involve people to understand their own specific situation and the consequences of their actions, and facilitate collective action for transformation; it still represents the first step to engage traditional excluded population through participation and strengthen the quality and intensity of rural community's integration.

Intervention Strategies

What makes the Ecological Home for the Andes an interactive learning space is the synergy of three different strategies: multidisciplinary research, technology development and dissemination and international service learning in engineering.

1. Multidisciplinary Research

The teams of students, professors and professionals that participated in the technological research and development (R+D) activities were from two different universities of Peru: Pontificia Universidad Católica del Perú (PUCP) and Universidad Nacional San Antonio Abad del Cusco (UNSAAC), and from two universities of the United States: Rensselaer Polytechnic Institute (RPI) and University of Colorado at Boulder (UCB). The technological R+D activities were conducted not only by students and professors form different fields of engineering, but also by professionals from architecture, social sciences and business carriers. Besides the technological R+D, the participation of students from other carriers generated research projects from anthropology, economics and cultural studies students.

2. Technology Development and Dissemination

The technologies of the EHA (see Table 1) have been designed by engineering students, professors and professionals gathered in groups as part of research projects and undergraduate thesis, implemented and validated in workshops with residents from different rural locations. The solar water heater, biodigestor and photovoltaic system were bought from enterprises since they already exist in the market.

Technology	Function	Approximate cost in USD
Photovoltaic System	Electrical power with solar energy.	$1,500.00
Radiant Floor	Heating system for the living area with solar energy to warm up the water located in a system of pipes under the floor.	$1,700.00
Warm Wall	Heating system with solar energy for the bedrooms based on the principle of the Trombe Wall technique.	$350.00
Heating Bed	Heating system with solar energy to sleep warm.	$700.00
Improve Stove	Adobe stoves with chimney that use biomass and expel the toxic smoke.	$190.00
Artisan Drill	Extract groundwater.	$100.00
Hand Pump	Pump the water extracted from underground	$80.00
Biodigestor	System for sewage treatment.	$1,000.00
Solar Water Heater	Solar powered water heater for the shower.	$600.00
Pasteurization System	Pasteurizer that remove bacteria from milk using dung, wood or solar energy as fuel.	$400.00

Table 1: List of Technologies Implemented in the Ecological Home for the Andes

During the first two years of technology implementation and in-situ demonstration workshops, residents of Langui and others districts of the province of Canas, and from others districts of the regions of Cusco and Puno who were trained as technicians in renewable energy technologies by the Institute for an Agricultural Alternative - Instituto para una Alternativa Agraria (IAA); participated in the fieldwork activities. In 2009, it was identified the importance of transfer the technologies that the community considered most relevant by capacity building activities. In this regard, GRUPO PUCP worked under the principle of learning by doing with male leaders of the local area in the construction, use and maintenance of improved stoves, warm walls and solar water heaters. They were trained and certified as specialists while they worked implementing those technologies in houses located in more than three rural locations around Langui, and in the health centre and Primary School of Langui. The adaptation in the use and maintenance of those new technologies by the adopter's families correspond to the process of technological innovation.

Over the past six years, local residents and people from other surrounding districts have been able to see in real-time the function of the technologies of the EHA through the demonstration workshops and guided tours by the students and the family in charge of the house management. Other dissemination activities based on the diffusion of a brochure and an institutional video to attract regional and local governments entities, so that incentive the replication of the technologies as an alternative to alleviate latent needs in rural people daily lives.

3. International Service Learning in Engineering

The EHA has been also an international exchange program where USA students work with Peruvians based on fieldwork activities as the core of the program since they have more advantages than traditional indoor classes in terms of its usefulness in facilitating students learning, as reported in Chak & Makino (2010), improve and strengthen student capacities and ensure a multicultural learning experience. The fieldwork in Langui has helped to university students improve their skills in the process of technological development because they implement and validate technologies under a real scenario tackling problems with a decision making process more quickly and effectively, and strengthen their capacity for teamwork. This can be supported by a survey taken in a Guatemala's program (Borg & Zitomer, 2008) were the capacity building in students was based in engineering skills and confidence, team skills, understanding of global contemporary issues and appreciation for ethical and professional responsibility.

Also, the creation of opportunities for feedback from potential users (residents) has allowed to the students exchange ideas, learn more closely the customs, beliefs, ways of working and organizing, priorities and needs from the rural sector. This knowledge, as a result of the multicultural experience, contributes to understanding and strengthening the role and importance of engineering in addressing specific needs and demands of people seeking development opportunities. Aydlett, Randolph, & Wells (2010) also pointed out that multicultural experiences expand upon the student's motivations and goals and generate benefits in the areas of cultural adaptation, knowledge acquisition, values and future career plans.

Impact and Sustainability

Housing has the potential to contribute significantly to any national target for greenhouse gases abatement, the EHA also wants to collaborate with a model of rural multi-family housing under the sustainability concept proposed by the Cooperación Alemana al Desarrollo (2011). According to the institution, a sustainable model of multi-family housing is an approach that seeks to balance the triangle of sustainability, which means the balance between the environmental, social and economic aspects, as shown in Figure 1. Therefore, a sustainable multi-family housing must consider since the design stage, sustainability criteria attributable to one or more phases of its cycle of life. These criteria include: energy efficiency, appropriate use (ethical) of resources (e.g. water, building materials), appropriate waste management, healthy spaces, quality of indoor-outdoor environment, reducing negative impact in the urban-natural and restoration of degraded environments. In this sense, the intervention strategies of the EHA and their results aims to ensure sustainability in many different levels in order to develop technologies in interaction with the community that represent effective solutions for social transformation.

The environmental aspect is considered in the EHA due to its eco-efficiency design and its technologies because they are mainly characterized by the use of traditional materials, natural and renewable energy resources. The purpose of is to reduce the environmental impacts of the life cycle of building materials, reduce energy and water consumption, reduce-recycle-reuse solid waste, restore healthy relationships with the environment through the landscape that respond to the climatic characteristics of the place. For instance, implementing an improved stove built with local materials decreased significantly the indoor pollution. In Gomez et. al. (2011) an study conducted in Langui local households reveal that indoor air quality was improved significantly after installing an improved stove in kitchens. The improved stove minimized emissions into the room and increased heat transfer and decreased indoor PM2.5 concentrations by almost 99% and black carbon (BC) concentration by 96%.

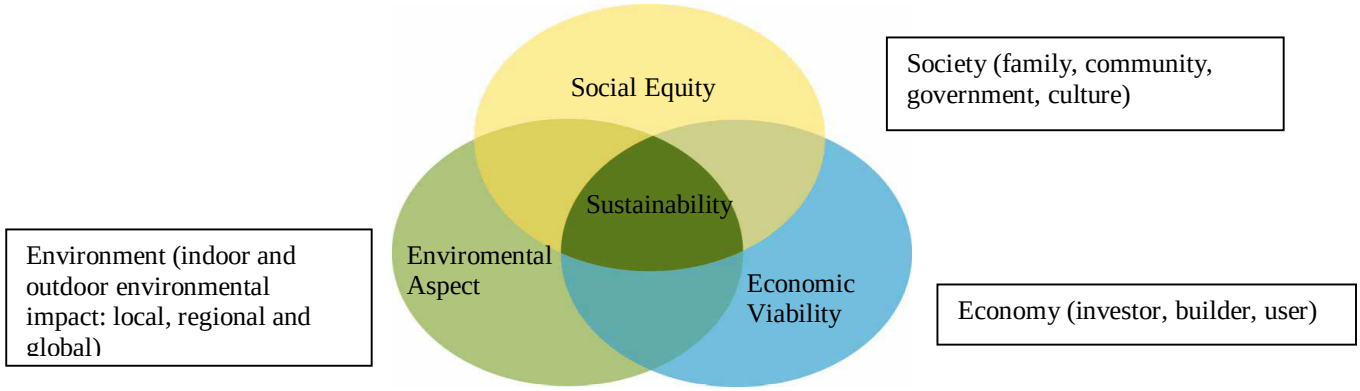

Figure 1: Triangle of Sustainability of Sustainable Housing

Source: Cooperación Alemana al Desarrollo, 2011.

With respect of the economic viability the usage of a combination of traditional and conventional materials that are adaptable to the local building system, makes the implemented technologies easy to maintain. However, the most important fact in terms of economic issues is that most of the technologies are related to improve health conditions related to respiratory diseases that are caused by cold and indoor pollution, as mentioned in Gomez et.al. (2011); consequently using them can reduce the spending amount on medicines and mobilization to the nearest rural medical centre. In the long-term the EHA is meant to be profitable because, according to Kristjanson et.al (2007), the main reason associated with the impoverishment of households is poor health and health related expenses. They claim that ill health not only reduces the earning capacity of the family members, but also the lack of facilities and conditions to access a good medical centre adds considerable expenses to the household. This is a double damaging effect which often results in the immersion of the household in extreme poverty.

Finally, to achieve social sustainability the three strategies looked forward to ensuring all actors participation since the local manager of the EHA until the local government authorities. Training the manager of the EHA and others community leaders in the implementation and dissemination of the EHA technologies facilitates the local process of technological innovation, strengthening capacities regarding to management, creativity, leadership and teamwork.

The certification to the trained community leaders is a means for income because they are hired as technicians and trainers in different projects related to technology implementation. Due to the EHA operates as a hub and eco-lodge for Peruvian and international researchers or professionals who go to work in Langui or in the area, and tourists, the participation of the local manager is a key factor for the administration and maintenance of the EHA. The family administrates the revenues that are reinvested in maintaining and help to increase their monthly income.

Another interesting example of social participation is through the demonstration workshops because they open a democratic dialogue between local families, workers of the local institutions such as the health centre and teachers of the Primary school and government authorities, to discuss the potential use of the EHA technologies and the possibility to incorporate its dissemination as part of the political agenda and the participative budget of the district. Furthermore, the election of the families who participate in other projects of technological dissemination proposed by the PUCP is the result of a democratic decision process with the participation of community leaders and local institutions.

Lastly and by no means less important, is that learning experiences based on fieldwork in a multicultural environment, enable local families to increase their social capital. In Guth (2005) the World Bank defines social capital as the set of norms and social relations inserted in the social structures of societies that allow people to organize action and to accomplish desired objectives. As a result of the participation and interaction over the years in the workshops and other activities, local families have consolidate relationships of collaboration with educative institutions that facilitate exchange and institutional learning processes.

Technology and Social Inclusion

The continuous learning experiences over the years between university and local population have generated confidence that reinforce the relationship, access to new information about technological alternatives to improve rural housing and also helped identifying opportunities for the project improvement. Under the social learning approach which aim is to achieve community empowerment where participants generated their own solutions to face daily problems, the EHA is in an early stage even though all the activities prioritize community participation and multicultural interaction. The weakness of the EHA initiative is that is not enough a passive participation of the local community, it is essential developing inter-learning process between traditional local knowledge and the technical scientific knowledge since the research phase, combining tradition with the new. Participation in all levels means returning the protagonism to peasant villagers in the workshops fostering their creativeness with horizontal interrelations between the facilitators of technology and users through the intercultural dialogue, eradicating unilateral impositions, taking into account the local forms of democracy, leadership, planning and decision-making.

In these sense, the EHA as an interactive learning space has not shift yet the roles of academic participants as service providers to facilitators and local families as passive recipients to co-experts, in order to ensure a process where all participants collectively find technological solutions to address local necessities or community empowerment. Nevertheless, it has given the opportunity of interaction between people from different cultural background to work on real problems, which result is valuable knowledge to improve the situation of exclusion and poverty. And precisely this interaction allows understanding how participation of vulnerable populations in technological projects can create minimum levels of integration as a community in the decision making process related to the function and opportunities that the EHA can create. Consequently, scientific, technological and innovation activities are not intended to minimize the effects of the exclusion of the poor, but to make possible the inclusion of all in the foreseeable future. Initiatives like EHA can create mechanisms of social inclusion by providing access to information about technological alternatives, promoting democratic decision-making processes, building capacities which encourage the local technological innovation dynamic and provide sources of income, and increasing their social capital based on interdisciplinary networks.

Conclusion

Having explained the different mechanisms of social inclusion that are generated by an interactive learning space for technological innovation like the Ecological Home for the Andes, it is important to reflect about its political significance to addressing poverty and exclusion in Peru.

The understanding or misunderstanding of the relationship between knowledge, technology and society by the key actors -the decision makers, technologists, scientists and engineers- has positive and/or negative implications in the upcoming political actions.

For that reason, as Thomas & Fressoli (2012) propose, it is necessary to make a strategic shift in the national science and technology policy, in order to align the production of scientific and technological knowledge to the satisfaction of social local needs and transversely incorporate a new concept of strategies based on the application of technologies to ensure social integration. Alzugaray et.al. (2012) claim that a specific way of expressing the university social commitment is through researchers working like "academic radars", thus; interactive learning spaces that foster technological innovation to meet local necessities give research agendas that integrate a diversity of actors.

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