

The experience of a Cuba-Spain scientific cooperation based on mathematics education: Building an effective model

Una experiencia de cooperación científica entre Cuba y España basada en la formación en matemáticas: Consideraciones para la construcción de un modelo efectivo

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Abstract

In the present article, we go through the key aspects of the cooperation experience between the Interdisciplinary Modeling Group – *InterTech* of the Universitat Politècnica de València (UPV), Spain and the University of Pinar del Río (UPR), Cuba in order to make some remarks on developing an effective model for cooperation with universities in developing countries; which may give rise shortly to a fruitful scientific collaboration stage focused on local educational development. We considered in our cooperation actions important issues faced by universities in developing countries and propose solutions to mitigate them. For instance, we discuss about how to prevent migration of young scientists and about a possible win-win relationship between universities from developed and developing countries. Our cooperation interventions are in line with the national and international efforts to help Cuban universities connect with the international scenario. Cuba was always pointed out by its noticeable achievements in education and health during the 70's and 80's, only that its general infrastructure was very affected by the economical crisis of the 90's and other issues derived from it. Some of these issues are discussed in this article based on our own assessment and analysis of the local context. At present, after over 20 years of collaboration, our research group has developed a wide spectrum of academic, research and cultural activities in the UPR and throughout the province of Pinar del Río.

Keywords: Educational development, North-south collaboration, University cooperation.

Con el objetivo de dilucidar los elementos fundamentales con vistas al desarrollo de un modelo efectivo de cooperación con universidades de países en vías de desarrollo, se analiza la experiencia de cooperación entre el Grupo de Modelización Interdisciplinaria (*InterTech*) de la Universitat Politècnica de València (UPV), España, y la Universidad de Pinar del Río (UPR), Cuba. La estrategia consiste en desarrollar una primera etapa de cooperación intensa, de manera que pueda dar lugar, en breve, a una fructífera etapa de colaboración científica centrada en el desarrollo educativo local. Los autores consideran en sus acciones de cooperación, cuestiones importantes que afrontan las universidades en los países en vías de desarrollo y proponen soluciones para mitigarlas. Por ejemplo, discuten sobre cómo prevenir la migración de jóvenes científicos y sobre una posible relación de beneficio mutuo entre universidades de países desarrollados y en vías de desarrollo. Las intervenciones comentadas en esta investigación están en línea con los esfuerzos nacionales e internacionales para ayudar a las universidades cubanas a conectarse con el escenario internacional. Cuba siempre se destacó por sus notables logros en educación y salud, fundamentalmente en las décadas de 1970 y 1980, pero su infraestructura general se vio afectada por la crisis económica de la década de 1990 y otros problemas derivados de ella. Los autores analizan estos temas en función de su propia evaluación del contexto local. En el presente, después de 20 años de colaboración, el grupo de investigación al que pertenecen los autores ha desarrollado un amplio espectro de actividades académicas, de investigación y culturales, tanto en la UPR como en la propia provincia de Pinar del Río.

Palabras clave: Educación para el desarrollo, Colaboración norte-sur, Cooperación universitaria.

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Introduction

Spanish institutions have a long history of cooperative work in Latin America. The fact that the Spanish language and culture are shared with most Latin American countries makes such cooperation more feasible.

Cuba was always known by its achievements in Education and Health mainly in the 70's and 80's. However, the general infrastructure of the country was very affected upon the collapse of the Soviet Union and its derived consequences are still influencing the national panorama nowadays. For instance, an important number of qualified professionals have left the country in the last two decades. This has been to certain extent the general situation of all the ex-Soviet countries in the last two decades (Takala and Piattoeva, 2012). In spite of the difficult situation, Cuba has made considerable efforts to keep the Educational and Health systems completely free for all Cuban citizens and at a reasonably good level. The Educational System in Cuba is still considered one of the best in the Developing World according to figures provided in the All Global Monitoring Reports by UNESCO.

Upon the economical crisis of the 90's, Cuba focused even more on the Biomedical Sciences, Pharmaceutical and Biotechnological industry which soon became an important source of income for the country. The National Pharmaceutical and Biotechnology industries are crucial in providing fundamental supplies to the National Health System. However, other research topics were less supported due to the deep economical crisis. Most of research actions were oriented to solve problems related to national key priorities such as Agriculture and Food Industry. Along with this, an important number of teachers, sport trainers, medical doctors were sent abroad to provide professional services around the world, mainly in less favored countries of Latin America

and Africa. Besides the solidarity purposes of these actions world-wide recognized, this activity also represents an important source of income for the country.

The history of international university cooperation of Cuba in the post-Soviet era (from 1990) involves a wide range of cooperation actions, most of them made available to the wider audience in the form of final reports (Iberoamerican General Secretariat, 2011). The majority of interventions have been mainly related to the main universities in Cuba, that is, The University of Havana, The Polytechnic José Antonio Echeverría (ISPJAE), The Agricultural University of Havana, The Central University of Las Villas (Santa Clara city), and The University of Santiago de Cuba. The smaller universities have been relatively less involved. The cooperation activities have included international training courses, scholarships (Master and PhD), support to carry out local training activities, improvement of the general infrastructure of the institutions, scientific cooperation, among others. Most of these actions have been developed in the framework of the priorities set out in the Cuban educational policies for science and education.

The decrease of the budget for educational cooperation has been a global phenomenon in the past decade. Wagner (2011) discussed about UNESCO as an international agency leader in literacy and its challenges in times of restricted budgets. A great part of the financial support for such cooperative work in Latin America has come from the Spanish Agency of International Cooperation for Development (AECID). The cooperation activities in Education, Culture and Development are included in the three priorities of this Agency along with Rural Development and Climate Change and Habitat (AECID, 2015). Nowadays, however, institutional funding for cooperation has been drastically reduced and, in tandem with this, there has been a severe weak-

ning of many related institutional mechanisms.

In this difficult context, we are progressing with our cooperative work in Cuba. This work began in 1996 with informal and isolated actions that gradually gave pass to a more organized strategy in 2009. Cuba is very close to Spain in terms of culture. In fact, most Cuban people have Spanish ancestry. This is an advantageous situation in the context of cooperation. Another advantage is the fact that the educational level in Cuba is high with respect to other countries in Latin America, notwithstanding the fact that its educational sector was very much affected by the economic crisis arising from the collapse of the Soviet Union in the 1990's. A great deal of Cuba's scientific and technological activity, as well as of its higher level postgraduate education, was until that time carried out in the framework of relations with the former Soviet Union (Takala and Piattoeva, 2012).

InterTech (www.intertech.upv.es) is a multidisciplinary research group, composed mainly of researchers and professors from two Spanish universities, the Polytechnic University of Valencia (Universitat Politècnica de València; UPV) and the University of Valencia (Universitat de València; UVEG). On the other side, the University of Pinar del Río "Hermanos Saíz Montes de Oca" is located in the most western part of Cuba, in the province of Pinar del Río, a region characterized by its biodiversity, extensive pine forests and agriculture. UPR's mission includes meeting the higher education needs of the province of Pinar del Río, which has a population of 589.021 inhabitants (National Office of Statistics of Cuba, 2015).

These groups first made contact in 1996 during the visit of members of the Applied Mathematics Department of the UPV to several Cuban universities as part of the academic support of a Master's degree in Advanced Mathematics for

Engineering. The University of Pinar del Río was among those Cuban universities enrolled for this program. From that moment and for the ensuing 12 years, there was a continuous cooperation in Science and Academic Programs between both entities, essentially covered by the following three projects which were financed by the Cooperation schemes of the Spanish government: (1) Cooperation project for the academic upgrade and technological support of the University of Pinar del Río (UPR), Cuba entitled "Formative actions of support to teaching infrastructure and research activities in the UPR. Formation of pre-university teachers (UPV-2001/2004)"; (2) Cooperation project in UPR, Cuba entitled "Specific actions in the areas of Mathematics and Physics (UPV-2006)"; and (3) Cooperation project entitled "Formative action for the support of the teaching infrastructure and research activities of UPR, Cuba (financed by the Spanish Agency for International Cooperation and Development in 2008)". These projects allowed the updating of teaching and research infrastructure of the Physics and Mathematics Departments of the UPR. At the same time, technical support to multiple postgraduate programs and research projects was provided.

Some of the activities carried out under the coverage of the aforementioned projects include: Postgraduate courses for technical disciplines with teaching and research focus; technological, scientific and pedagogical support for the academics participating in the courses; upgrading of computer infrastructure, and donation of printed material to guarantee consistency of course content in future years; supervision of PhD and Master Degree theses; editing of textbooks and scientific papers written by Cuban professors; organization of Conferences on Teaching and Research in Engineering; and Financial support to the mobility of the academic staff of both universities to participate in academic and research activities. Throughout years of cooperation, the

diverse material donated to Cuba has also reached the people of the region. These donations have included hospital equipment and material for some of the health centers of the province.

Although the fact that the years 1996 to 2008 saw a lot of cooperative work among professors and researchers from both universities, this period was characterized by rather *isolated efforts* and *spontaneous activities with point effectiveness*, without following a *global cooperation strategy*. In the present article, we focus on the period from 2009 to the present when a new scenario emerged, and a formulation of a global cooperation strategy was possible.

In this article we go through the key aspects of our cooperation experience with Cuba aiming at the establishment of a more effective model which could be extrapolated to the context of other research groups in developed countries willing to work along with universities in developing countries.

The outline of the article is as follows. First, we make an analysis of the context at the advent of year 2009 based on the experience gained in the previous period from 1996 to 2008. Later on, the elements of the new scenario and the structural components of our cooperation strategy towards a cooperation model are explained. Subsequently, the main results and two prospective projects are discussed. Finally, some conclusions are drawn.

Remarks on the period from 1996 to 2008

The detailed analysis of the period 1996-2008 allowed us to conclude that if we want to develop a more effective cooperation, our actions should be organized in a global strategy based on the deep knowledge of the local scenario. In the following, we will comment on some items we considered of importance in planning a new period of cooperation.

Science for curiosity or science for utility?

Science for curiosity or science for utility? From this question a contradiction in the developing countries arises. On the one side, there is an urgent need for solving the primary problems of local development; and on the other, the scientific institutions of the country should be strengthened by means of addressing scientific problems (problems new to Science). The local problems relating to the production of first needs come in most cases from the impossibility of importing or developing the proper technology. The solution of such non-scientific problems is usually not conducive to publications in scientific journals or to any other scientific products. The facing of scientific problems is not a main task of universities in Cuba, but rather of research institutes. Universities are meant to focus on solving problems of the production and services by the aid of the scientific methodology. Cuba counts on a national network of research institutes mainly devoted to pharmaceutical and bio-medical research providing solutions for the needs of the Health System. These institutes also export different biomedical products which serve as an important source of income for the country. The development of biomedical sciences in Cuba is a good example of research on priority (Castro, 2002).

In Cuba the funding of science is mainly concentrated on a narrow group of topics linked to the national priorities for development. Countries with little funding for science cannot afford extensive curiosity-driven science; instead, they must focus as much as possible on utility-and innovation-driven science. Altbach (2007) considered creating research universities focused on national priorities as part of development efforts.

Another interesting discussion is about basic research in developing countries. Although the lack of funds suggests that first needs applied science should be afforded priority, to completely

neglect basic science research might prove very risky. The value of basic research in relation to innovation and impact on society has been highlighted in a number of publications (Calvert, 2006). The more basic science is performed the more innovations are produced and along with this, the greater the number of patents. Indeed, developing countries should not neglect activity in basic sciences at all because to do so can lead to the gap with developed countries increasing still further. Local actors should be more involved in conceptualization stages of the projects and not only in the application and development stages.

Need for a new paradigm on doing science in developing countries. Developing countries cannot follow the rhythms, styles and ways of organization of science of developed countries, which are usually very institutionalized and connected to market needs. There should be a different research agenda for developing countries with respect to developed countries. Developing countries must find their own formulae to focus scientific research on the coverage of primary needs and, in this way, start an increasing development. Altbach (2007) indicated two core elements in this respect: (a) the importance of creating and retaining an academic community; and (b) bringing international trends to the developing country context. New paradigms should be found for the management of science in developing countries.

Although the fact that poor quality of scientific results should not be justified by the unavailability of proper conditions, it is also true that many things can be done to give more opportunities to less favored countries. To think of this is to think of “Cooperation in Science” for development. For instance, the Foreign Agricultural Service of the United States Department of Agriculture has provided support to more than 400 projects in about 90 countries for enhancing the skills of agricultural professionals (FAS, 2015).

The science scenario is very complicated in developing countries since funding is essentially devoted to cover basic needs. Scientific activity cannot be separated from this reality. Those countries investing more funding in research will make the biggest overall progress. This situation leaves the developing countries in a very unfair position in terms of global competition. The pursuit of an answer to this question is a major issue for developing regions. Cooperation agencies of developed countries usually operate under country-specific priority programs when addressing cooperation actions with developing countries. The funding is usually concentrated on priority topics with impact on social development (AECID, 2015).

The way of projecting science in developing countries should not be the same as for developed countries. We think that there is a big problem of reward. Commonly, the only type of science management that is rewarded nowadays is that following the indicators defined in developed countries. New indicators to assess the quality of science in developing countries should apportion a greater weight to the impact of scientific activity on solving urgent problems of development. Important efforts in this direction have been made by the Iberoamerican and Interamerican Network for Science and Technology Indicators with headquarters in Buenos Aires, Argentina (RICYT, 2014).

In the case of Cuba, and differently from other developing countries, many experts agree on the fact that there is a reasonably good organization of the Science National System which prioritizes the country’s most urgent needs; nonetheless, this has been deeply affected by the economic crisis, the still insufficient international interchange, and the continuous migration of young scientists.

Migration of scientists. Young scientists often stay in developed countries after Master or PhD

studies. It is a very common phenomenon that the education and training in developed countries, of scientists from the developing world, leads ultimately to those scientists' migration. We consider that there are many factors which influence this process, with three being particularly powerful: (1) lack of commitment to country of origin; (2) lack of vacancies for these scientists in their home institutions upon return - such scientists usually develop research in areas non-existent in their home countries which are rather of importance for the host country (Mayor and Forti, 1995); and (3) salaries are usually lower in their home countries. New formulae must be created to overcome this difficulty. The gap between developed and developing countries is increasing every year. Brock-Utne (1996) discusses the uneven distribution of resources to higher education between the North and South. Kofi Annan, the ex-Secretary-General of the United Nations, referred to the inequalities in science between developing and developed countries and stressed the major challenges in building bridges across these gaps (Annan, 2003).

A solution to this could be that scientific cooperation projects involving developed countries and developing countries be carried out *in the developing countries* by mutual agreement, or by hiring oversea workforce. In the next section we show how our model of cooperation performs in overcoming this problem. This solution might require the creation of new schemes to establish compatibility between two different systems, with such different characteristics. In developed countries scientific schemes are very well established, indeed institutionalized, usually demanding very specialized professionals in their different fields. On the contrary, science management in developing countries will most probably go through the fostering of local scientific leaders with a wide profile around whom research groups could be built. Annan (2003) indicated that the number of scientists in proportion to population

in the developing countries is 10 to 30 times smaller than in developed countries, and that 95% of the new science in the world is created in the countries comprising only 1/5th of the world's population. This situation quantifies the big gap between developing and developed countries. Research agendas should not be measured with the same scientific indicators in both contexts (Holmgren and Schnitzer, 2004).

It is critical to develop an effective way to mitigate the migration of qualified scientists from developing to developed countries. Scientific cooperation may be able to contribute to the alleviation of this problem. It is very costly to form a good professional. One important point is that scientists should never lose their connection with the reality they are trained to serve. In this respect, the profile of scientists of developed countries should not be the same as in the developing countries. In the latter, the formation of a PhD student should most probably include skills for writing a research project, working in teams in multidisciplinary environments, or leading a scientific group. In order to pass on the knowledge to new generations, teaching skills may also be required. However, PhD students in developed countries focus on very specific tasks in their research and may not need to consider the loop of science from research to applications which is very well institutionalized in developed societies. In developing countries scientists should understand and take part directly in every step of the loop.

Crisis of the scientific workforce – a new south-north relationship is required. As research funding has decreased in Spain, so the scientific workforce has decreased. Many scientists are migrating due to the lack of job offers in their research areas. A migration outflow of 340.000 people was reported in 2010 (OECD, 2012). At the same time the population ages every year and not so many youngsters seem to be interested in

studying sciences which is a global trend (QS World University Rankings, 2013).

A means of addressing the needs of both north and south may be through new paradigms of scientific relations with developing countries under mutual and fair agreements. The developed country gains in work force and the developing countries increases the level of their research as a function of the specific needs of its target regions. The model presented in this work goes in that direction.

Public universities in developing countries. In Cuba, universities have a deep relationship with the regions where they are located. By means of undergraduate and postgraduate studies, research, and outreach activities, universities contribute to the preservation, development and promotion of culture in the regions (Higher Education Ministry of Cuba, 2015). This fact is an opportunity that favors cooperation with Cuban universities. From this social commitment, cooperation activities flow more naturally, whether with universities or with the region. The universities in developing countries are often the most important cultural centers in the regions where they are located. There is no other institution with greater regional cultural influence. In this respect, public universities become key targets and mediators of the cooperation activities.

Even when there is a big international debate on the role of higher education in society in general, and in communities in particular, there is general agreement with the notion that apart from teaching and research, universities have a *third mission* (UNESCO, 2008), which is Community Engagement. Correa *et al.* (2012) pointed that community engagement in higher education is a shift beyond the traditional missions of instruction and research. Cooper (2005) also discusses the moral accountability of universities to society and their responsibility in the process of social transformation.

As for research, the role of Cuban universities is to support the scientific priorities of the country and the region where they are settled, and even more importantly to offer scientific solutions to local problems of production and services. The priorities of research activity in Cuba are established by the National System of Science and Technological Innovation coordinated by the Ministry of Science, Technology and Environment.

Commitment of the parties to the cooperative process. In order to secure ongoing involvement and commitment of the local authorities in and to the cooperation, it's recommended the signature of mutual agreements under local and international laws. The establishment of mutual agreements will contribute to the stability of long-term projects.

The success of a cooperative project from the beginning depends on the knowledge of the local context; that is, it depends not only on the specific partner in the process but also on the political, economical and social panorama of the region. Sometimes it is very difficult to get into agreement with the local authorities, and even more difficult to secure a high level of commitment in order to guarantee the effectiveness of the project. In this respect, the development of a cooperative project implies a continuous process of negotiation with the local actors.

The important role of interpersonal relationships. Another key aspect of success in our cooperation activities has been the development of personal relationships of solidarity and fraternity with the local actors. Often local actors can be reluctant to become involved with collaborators from abroad. This is something that has to be handled considering the importance of common interests and personal relationships. In the end, the possibility of helping people in need should be the greatest prize and motivation for collaborators. Interpersonal relationships can keep

cooperative relations alive even in difficult times, for example in cases of funding cuts.

Our experience is that participation in such kind of activities is in itself rewarding for those who are willing to collaborate to others. People usually join such projects informally and without receiving anything tangible in return. However, the development of a cooperative project also demands very strict discipline in the fulfilling of the different tasks. This fact makes the profile of cooperators very singular with respect to the profile of people working for universities or companies since motivations may be very different.

Increasing feasibility of conducting modeling and simulations in developing countries.

Nowadays, availability of powerful computers opens different possibilities as simulation-based research in developing countries. This type of computational research is a low-cost alternative to costly experiments which offers good perspectives for developing countries. New collaborations can be established based upon the possibility that research groups in developing countries undertake modeling and simulation of experiments performed in developed countries.

The possibility of intensive computational modeling and simulation has fostered multidisciplinary research, allowing the addressing of more complicated systems, e.g. biological ones. Nowadays it is possible to construct models which integrate concepts of several disciplines and run simulations on powerful computers. In light of this, most journals have made their scope broader to cover even more multidisciplinary research. One good example of a discipline born on the advent of powerful computers and progress in numerical methods and computational algorithms is Bioinformatics, area in which *InterTech* has developed part of his research. Computer simulations are transversal to all disciplines and offer very good perspectives for scientific roles in developing countries.

The experience of the *InterTech* group in interdisciplinary research is an opportunity in this sense. In developing countries like Cuba, integral solutions to important problems demand a multidisciplinary focus.

Opportunities at the University of Pinar del Río.

The University of Pinar del Río hosts a significant number of young trainees whom it is expected to become lecturers in coming years. These trainees are recent graduates who hope to go through master and PhD degrees, whilst simultaneously climbing the hierarchy of teaching grades: Instructor Professor, Assistant Professor, Auxiliary Professor and Titular Professor. In order to be Titular Professor, the candidate must hold a PhD degree and show extensive teaching and research skills. This young workforce with a need for scientific and academic development is an ideal setting for academic and scientific cooperation.

A new period in the cooperation relationship (2009-present)

In 2009, a new period in the relationship between *InterTech* and the University of Pinar del Río began, as a new scenario with better chances for a deeper and more integral impact emerged. From 2009 onwards, we have planned and acted on the basis of a global strategy. As follows, we will comment on the elements featuring this scenario and, on the structural components of our cooperation strategy.

Elements of the new scenario. A very important step was taken in 2009 when the University of Pinar del Río and the Polytechnic University of Valencia agreed on signing an intention of mutual Collaboration Agreements taking advantage of an existing framework of bilateral collaboration. These Agreements contain the general items of mutual collaboration interests among which “Cooperation in Science and Academic Programs” was included.

In 2009, we also obtained three years of financing from the Government of Valencia (Generalitat Valenciana), Spain, for a project titled “Acciones educativas, deportivas, sociales y sanitarias en la UPR (Cuba)” [“Actions in Education, Sports, Society and Health System in the University of Pinar del Río (Cuba)”] (Final report of Cooperation Project No. 3012/2009, 2012). This project financed multiple postgraduate programs, as well as research and cultural activities.

In 2009, the development of a joint PhD agreement began. The University of Pinar del Río had the need for formation of professionals in Modeling and Simulation Topics in multidisciplinary contexts and with extensive use of computational resources. The *InterTech* group agreed to the supervision of 15 PhD theses on topics of local interest involving modeling and simulation. The PhD students from the University of Pinar del Río engrained in the joint PhD agreement are intended to obtain the PhD degree in Applied Mathematics by the Polytechnic University of Valencia. Most of these topics are related to Engineering and Bioinformatics. The PhD students enrolled in the Program were young trainees of the University of Pinar del Río with a Master’s degree in a related area. We will comment more on the features of this Program further down in this article.

Last but not least, an important element of the new situation was the scientific experience of the Interdisciplinary Modeling Group - *InterTech* by the year 2009. After several years of scientific and academic work, *InterTech* group reached 2009 with a scientific maturity. The main topics of the group included the modeling and computational simulation of heat transfer, the simulation of electromagnetic propagation in optical systems, and the optimization of problems in the field of Bio-Systems. By 2009, the *InterTech* group was in a very favorable scientific condition for assuming the supervision of 15 PhD students and

for the development of Academic Postgraduate Programs.

The structural components of the cooperation strategy. In Figure 1, a diagram with the structural components of our cooperation strategy is shown. These components are as follow: *InterTech* group (UPV), *InterTech*-UPR (a mirror research group at the University of Pinar del Río), Non-governmental organization (NGO) “*InterTech Cooperación*”, a Linking Office and the funding from the Central and Regional Governments of Spain. The management of the interplay of these components is the major challenge.

The University of Pinar del Río is for us a fundamental mediator in facilitating our actions in impacting the university itself and region as a whole. As stated earlier in this article, public universities in developing countries play an important role as main cultural institutions in the territories. The mission of the universities includes the direct attention to the Academic Formation and Science needs in the territories where they are located.

For fluid communication and feedback from the local scene, a Linking Office was created. This Office is peopled by a team with members of both entities involved in this project. It was settled in the University of Pinar del Río, that is, the place where actions were carried out. Its mission is to register and control all the information generated during the cooperation actions as well as to have full knowledge of the local procedures in both settings for advisory purposes. Furthermore, this Office plays a major role in dealing with the excessive bureaucracy which may exist in the management of the scientific activity (Figure 1).

The core of the collaboration with the University of Pinar del Río is the *InterTech-UPR Research Group* officially founded in 2010. This is a mirror group of *InterTech* group at the Polytechnic University of Valencia. As in the latter, the group

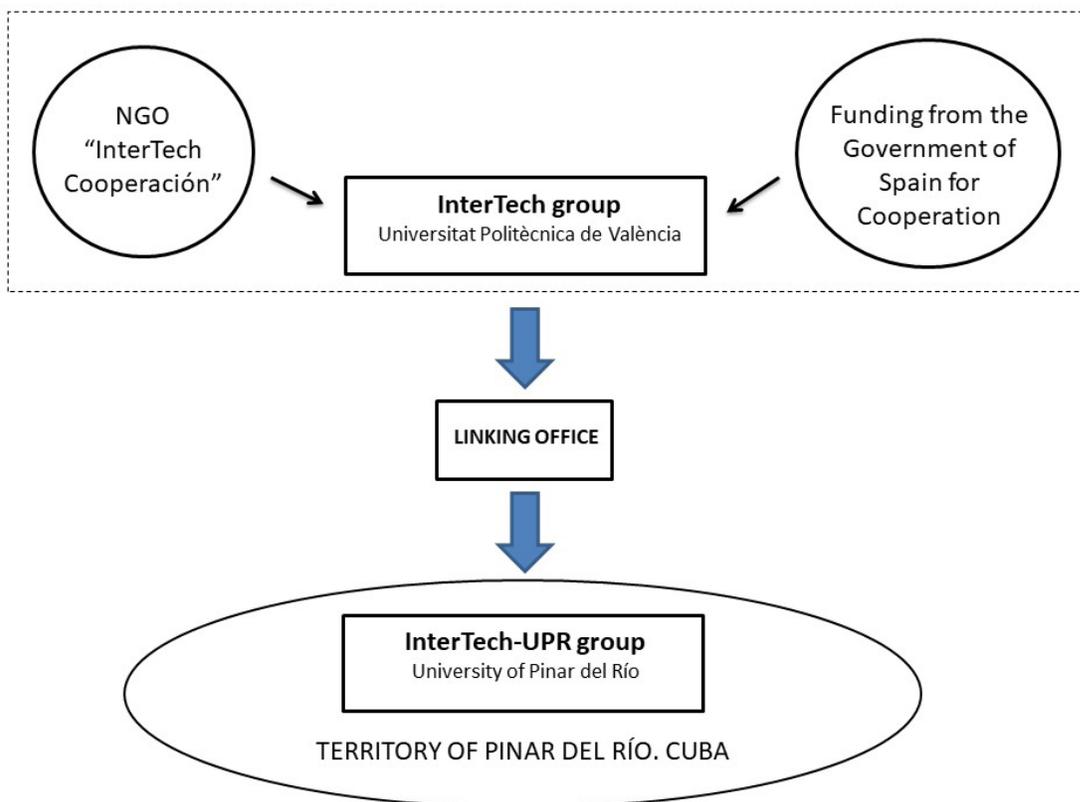


Figure 1. Structural components of our cooperation strategy.

at the University of Pinar del Río is based on modeling and simulation of multidisciplinary problems. It uses the same methods and methodologies as used by *InterTech* group in UPV but applying them to contexts relevant to the basic needs of the territory of Pinar del Río. This group was composed of the PhD students of the Academic Program alluded to above and by other professionals with experience in these topics. A fundamental issue was the selection of a local scientific leader having a strong background in simulation and modeling around whom the group was to be cored.

The existence of a group on modeling and simulation of engineering problems at the University of Pinar del Río provides the professionals of basic sciences of the University and the territory of Pinar del Río with new research roles. This is the case for Mathematicians, Physicists, Biologists,

and Informatics Engineers. This group is the first one on modeling and simulation created in this territory. As commented above, mathematical and computational modeling may contribute to assembling the different disciplines in a research group.

The funding of the cooperative activities came largely from the schemes for cooperation of the Government of Spain at both Central and Regional levels; in particular the Spanish Agency of International Cooperation for Development (AECID) and the local government of Valencia region (GVA). Some funding also came from schemes of the Polytechnic University of Valencia and the University of Valencia. It should be pointed out that these sources of funding were drastically decreased as the economic crisis of Spain unfolded.

In order to establish stability of funding for the

cooperation, the non-governmental organization “*InterTech Cooperación*” was created. The NGO is made up of people who are committed to the aims of our cooperative actions and is based in Valencia City. Its main activity is the collection of funds by means of developing a great variety of sensitization activities. The work of this NGO has been crucial in stabilizing the financial aspects of our work.

Current results and prospective projects

As aforementioned, one of in the previous section, one of the main cooperative actions was the opening of a joint PhD agreement for students of the UPR in 2009. A distinctive aspect here is that the PhD students perform most of their PhD research in Cuba. This fact prevents the PhD students from being disconnected from their activities as professors in training of the UPR. They undertake scientific stays with the *InterTech* group of Valencia for periods of about three months per year. During these three months, they work in close contact with their supervisors and take the opportunity to review the most recent literature. When conducting their research in Cuba, they keep in close contact with the supervisors by email or any other communication means available nowadays. This is possible because modeling and simulations depend basically on scientific information, software and computer power. The PhD program is the core of the Cuban *InterTech* group which was founded in 2010. This group is a research structure officially recognized by the University of Pinar del Río.

Until now, 10 PhD theses have been successfully presented by Cuban PhD students in Valencia. The remainder of the initial intake of 15 is expected to complete in the next few years. This PhD program takes longer than the standard three years, but this is mainly due to the PhD students combining their doctoral research with their activities as staff of the University of Pinar del

Río. An important feature of our program is that it incorporates new doctoral candidates in order to keep the number of 15 students in the program.

This increase in joint research activity leads to an increase of the number of publications. From 2009 to late 2018, 25 articles have been published in peer-reviewed journals and also in a wide spectrum of regional and national journals. These articles represent an important percentage of the total production of articles of the Faculty of Engineering of the University of Pinar del Río. This is a good measure of the scientific impact of the cooperative project. The significance of this development is clear in light of the fact that Cuban research mostly began to appear more often in international journals in the 1990s, after the collapse of the Soviet Union; before this, a culture of publishing in international journals hardly existed. Some of these aspects in the post-Soviet Union era are discussed by Takala and Piattoeva (2012).

While international publication is essential, the visibility of scientific output in the national context is also very important; therefore, it is necessary to publish the results in regional and national journals. Most developing countries do not have access to the major scientific journals. In the framework of our cooperation, several books containing local results were edited and published, with a Spanish ISBN number which makes the local work universally referenceable. Furthermore, as research activity has increased, not only publications and PhD theses but also participation in international conferences, international projects and networks have increased. All these facts impact enormously on the international visibility of the University of Pinar del Río.

Other outcomes include multiple academic courses such as Modeling and Simulation in Engineering, Scientific Software in Engineering Modeling, Science Communication and Writing

of Scientific Articles, Search Tools in Scientific Databases, among others. An important part of the results of our cooperative activities in the period 2000-present coincide with those derived from the Cooperation project “Actions in Education, Sports, Society and Health System in the University of Pinar del Río (Cuba)” (GVA, 2009-2012) which was already mentioned above. More details on the results can be found in the final report of the project from June 2012 (Final report of Cooperation Project N° 3012/2009, 2012).

Prospective projects

Possible foundation of a University Research Center on Modeling and Simulation. As previously outlined, the PhD agreement development is the core of the *InterTech* group at the University of Pinar del Río (UPR). This group is a research structure officially recognized by this university. In coming years, as the scientific output and the number of graduates with PhD increase, this group should rank higher in organization and become a University Research Center on Modeling and Simulation, which is a more formal research structure of UPR with authority to fully manage research funds and organize postgraduate programs. This center is also expected to serve as a linking platform for further cooperation or networking interventions with Latin American countries.

The progress of the *InterTech* group at the University of Pinar del Río was designed to have two stages. First came the cooperation (*aid and support*) period characterized by important contributions from the Spanish actors in terms of infrastructure, such as donation of computers, professional computer software, and scientific literature. This basic infrastructure covers not only material infrastructure, but also scientific organization and basic scientific formation of the human resources.

Later on, the collaboration (equal exchange) would come; that is, a period when, local actors would start contributing. The intention is to work intensively on the cooperation period so as to enable the collaboration period to emerge as quickly as possible. In this way, the Spanish scientists would have extended their network of collaborators to a developing country. This is very welcome in times when a crisis in the scientific workforce arises.

By the end of the second stage, the group should meet the official requirements to become a University Research Center on Modeling and Simulation. Taking into account that the number of doctors will by then be adequate, the conditions would be created to carry out the *Master's program in Mathematical Methods and Models in Interdisciplinary Research* which will be discussed in the next section.

Master's program in Mathematical Methods and Models in the Interdisciplinary Research. An important project planned in the framework of this collaboration is the Master's program in Mathematical Methods and Models in Interdisciplinary Research. This program was proposed by a set of researchers coming from the *InterTech* group of Valencia, the Cuban *InterTech* group and professors from the Technical University of Chocó (TUC), settled in Chocó, a region of the pacific coast of Colombia, and intended to be carried out in the TUC.

The idea is to employ the collaboration activities with Cuba as a launching platform to other Latin-American countries. The students of this Master's degree would come from the region of Chocó and other regions of Colombia. On the other hand, the academic staff of this program would count on the collaboration of several professors from the University of Pinar del Río and the Polytechnic University of Valencia.

This will be our first experience involving cooperation with two developing countries. The vast experience of Cuba in South-South cooperation and collaboration is a major advantage in this respect. Chisholm and Steiner-Khamsi (2009) discuss how South-South cooperation can be seen as a form of collective organization to carry out projects which will improve the position of the participating countries on a global scale. The networking framework for work of this nature is difficult to set up but once established it may contribute appreciably to the stability of the cooperation projects.

Conclusions

The key aspects of the cooperation experience between the Interdisciplinary Modeling Group – InterTech at the Universitat Politècnica de València (UPV) and the Universitat de València (UVEG), Spain, and the University of Pinar del Río (UPR), Cuba from 1996 until present have been briefly outlined. For a clearer narrative, the whole period has been divided into stages which render visible the overall strategy. The structural elements of this strategy for developing a cooperation model have been discussed. In summary, the main contributions of this experience to the local setting are listed as follows:

- The foundation of a research group (*InterTech-UPR*) in the University of Pinar del Río was the core of the scientific cooperation. This group takes the tools of modeling and simulation developed by the homonymous group in the UPV and applies them with a multidisciplinary focus to problems related to the basic needs of the region. This group is an official scientific structure of the UPR, a status which confers some guarantee of its ongoing existence.
- The present possibility of doing research on Modeling and Simulation in developing countries opens new possibilities in these

countries.

- The *InterTech* group founded in the UPR was cored around a PhD program of 15 students who are young professors in training of this University. This PhD program is developed in a *sui generis* way that allows the PhD students to do research while simultaneously attend to their responsibilities as staff of the UPR. This is a distinctive feature of our strategy and seems to be suitable for the context of developing countries.
- Along with the increase in research activity, the number of publications and participations in international projects and conferences also increased. This is an important step towards increasing the visibility of the UPR in the international scientific scenery.
- A more indirect contribution is the increase in local scientific standards by the introduction of new researchers with PhD in Applied Modeling and Simulation who were trained in Europe.
- We should also mention that the community working on modeling and simulation in the territory of Pinar del Río has been considerably strengthened. This fact has allowed new research roles for the professionals of the basic sciences in the region in relation to the research topics of local interest.
- The possibility of involving several Latin-American countries in academic programs using Cuba as a linking platform is very interesting. Cuba is located in a very convenient geographical position between Europe and Latin America. Furthermore, the educational standard of Cuba is high compared to other countries of the region.

For us, ‘Cooperation’ in simple words means altruism, refers to the pleasant feeling experienced when the emotion of solidarity is shared and, after cooperation activities have been finished, is what remains in terms of long-lasting benefits for local people.

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Literature cited

- AECID. 2015. MAEC-AECID Grants and Assistantships: 2015-2016 period. Disponible en: <http://bit.ly/2Zlx61J>
- Altbach PG. 2007. Peripheries and centres: research universities in developing countries. *Higher Edu Manag Pol.* 19 (2): 111-34. Disponible en: <https://ideas.repec.org/a/oec/edukaa/514mf9phjk9q.html>
- Annan K. 2003. A challenge to the world scientists. *Science.* 299: 1485. Disponible en: <https://doi.org/10.1126/science.299.5612.1485>
- Brock-Utne B. 199. Globalization of learning – the role of the universities in the South: with a look at Sub-Saharan Africa. *Inter J Edu Develop.* 16(4): 335-46. Disponible en: [https://doi.org/10.1016/S0738-0593\(96\)00055-7](https://doi.org/10.1016/S0738-0593(96)00055-7)
- Calvert J. 200. What’s special about basic research? *Scie Technol Human Val.* 31: 199-220. Disponible en: <https://doi.org/10.1177%2F0162243905283642>
- Castro F (ed.) 2002. *Cuba: Amanecer del tercer milenio: Ciencia, sociedad, y tecnología.* Madrid: Editorial Debate; 416 pp.
- Chisholm L, Steiner-Khamsi G. 2009. *South-South Cooperation in Education and Development* (International Perspectives on Educational Reform Series). Press/HSRC Press; 312 pp.
- Cooper C. 2005. Accounting for the public interest: public ineffectual or public intellectuals, *Accounting. Aud Accounta J.* 18 (5): 592-607. Disponible en: <https://doi.org/10.1108/09513570510620466>
- Correa MA, Butcher J, Howard P. 2012. An international comparison of community engagement in higher education. *Inter J Edu Develop.* 32: 187-92. Disponible en: <https://doi.org/10.1016/j.ijedudev.2011.04.008>
- FAS. 2015. Agricultural Service of the United States Department of Agriculture. *Webpage with databases, featured reports, and latest reports of the Foreign.* Disponible en: <http://www.fas.usda.gov/data>
- Final report of Cooperation Project N° 3012/2009. 2012. Actions in education, sports, society and health system in the University of Pinar del Río (Cuba), financed by the Government of Valencia, Spain, in the years 2009-2012.
- Higher Education Ministry of Cuba. 2015. Mission statement. Disponible en: <http://www.mes.gob.cu/index.php/2013-05-21-15-58-34/mision>
- Holmgren M, Schnitzer SA. 2004. Science on the rise in developing countries. *PLoS Biol* 2 (1): e1. Disponible en: <https://doi.org/10.1371/journal.pbio.0020001>
- Iberoamerican General Secretariat. 2011. Report on South-South Cooperation in Ibero-America 2011. Disponible en: <http://bit.ly/35YHuia>
- Mayor F, Forti A. 1995. Science and Power (Challenges series). UNESCO.
- National Office of Statistics of Cuba. 2015. Population census of 2015. Disponible en: <http://www.one.cu/estadisticapoblacion/estadisticapoblacion.asp>
- OECD. 2012. Organisation for Economic Co-operation and Development. Migration policy and migration statistics: country notes. Disponible en: http://www.oecd.org/migration/mig/IMO%202012_Country%20note%20Spain.pdf
- QS World University Rankings. 2013. World University Rankings Reflect Growing Demand for STEM Subjects. Disponible en: <http://bit.ly/2QpMvdo>
- RICYT. 2014. Annual Publication on the State of Science in Iberoamerica in 2014. Sp: El Estado de la Ciencia, 2014. Retrieved from: <http://www.ricyt.org/publicaciones>
- Takala T, Piattoeva N. 2012. Changing conceptions of development assistance to education in the international discourse on post-Soviet countries. *Inter J Edu Develop.* 32(1): 3-10. Disponible en: <https://doi.org/10.1016/j.ijedudev.2010.10.003>
- Wagner DA. 2011. What happened to literacy? Historical and conceptual perspectives on literacy in UNESCO. *Inter J Edu Develop.* 31(3): 319-23. Disponible en: <https://doi.org/10.1016/j.ijedudev.2010.11.015>