



SUMMER 2014

## Assessing an Entrepreneurship Education Project in Engineering Studies by Means of Participatory Techniques

LEOVIGILDA ORTIZ-MEDINA

ELVIRA FERNÁNDEZ-AHUMADA

PABLO LARA-VÉLEZ

ANA GARRIDO-VARO

DOLORES PÉREZ-MARÍN

AND

JOSÉ EMILIO GUERRERO-GINEL

University of Cordoba

Cordoba, Spain

### ABSTRACT

The new imperatives of the knowledge-based society require engineering students to equip themselves with a broad range of skills, among which entrepreneurship plays a critical role. An academic itinerary was designed with the explicit aim of improving the entrepreneurial attitudes of agricultural engineering students in a state university in southern Spain. Within a wider research framework, this paper focuses on an evaluation of that itinerary using participatory techniques, and on a discussion of the lessons learned in the course of ten years of running the program. The findings highlighted the importance of building a solid support network involving a whole range of aspects and actors, and of carrying out continuous monitoring. The incorporation of this program into the standard curriculum, with a view to ensuring continuity, needs to be combined with other elements such as tutorship, thus providing a flexible response to the students' various needs and demands. Training based on authentic learning, alumni participation and teamwork is recommended. The impact at a personal level is an extra dimension to be borne in mind. The participatory rural appraisal (PRA) methodology proved extremely useful for the purposes of program evaluation, enabling core issues to be identified. The authors would recommend taking the risk of running an entrepreneurship program even if conditions are not entirely favorable. The intensity and enthusiasm of day-to-day work in entrepreneurship education can instill a degree of commitment and motivation in students and academic staff, and inspire them to tackle new challenges.

**Key Words:** entrepreneurship education, engineering studies, bottom-up approach



## INTRODUCTION

New social imperatives have rendered it essential that universities assume a responsible role as trainers of good professionals capable of entering, and thriving in, the workplace. Improving students' employability is now more than ever a key aspect of education, and one that all universities are obliged to tackle. In engineering fields, university departments should seek to provide students with a broad range of skills and knowledge beyond the merely technical [1], including good communication skills, expertise in multidisciplinary teamwork, entrepreneurial spirit, global and multilateral approaches to problem-solving and sensitivity to the cultural, social and economic environment [2].

In a similar vein, Papayannakis et al. [3] argued that the inclusion of entrepreneurship education in university curricula should not arise as an application of policy initiatives related only to economic imperatives; instead, it should be part and parcel of a more general discussion regarding educational priorities, and of a strategic design for university curricula aimed at providing engineers with entrepreneurial and management skills that will enhance their profiles in accordance with the new requirements of the knowledge-based economy.

It was within this context that a group of academics in the agricultural engineering department of a state university in southern Spain, aware of the gap between academia and business, and of the need to reflect on their mission, their procedures and educational systems in general, realized that the university's traditional roles had to be augmented with new competencies. It was felt that the university should provide additional training to engineers, enabling them to respond better to new demands, and assume social responsibility for promoting entrepreneurship, involving as many actors as possible in an accompanying support network.

Over the last 30 years, this group has focused both on teaching and on improving students' employment opportunities, supervising a number of programs aimed at fostering rapprochement with the real world, solving real problems and implementing periods of in-house training within enterprises.

Against the backdrop of the Bologna process [4], which highlights the need for changes both in teaching and learning methodologies and in their evaluation, a growing interest in encouraging entrepreneurship and incorporating it into the engineering curriculum led the group to launch a project aimed at ascertaining which processes best nurture entrepreneurial attitudes within the university environment.

The group found that it had much in common with those authors who highlight the major role of education in promoting entrepreneurial attitudes and behaviors, and in increasing the number of people aware of, and interested in, entrepreneurship as a career path [5].

Ten years ago, although the problem of youth unemployment was not as serious as today, the context was already characterized by constant changes and uncertainty, with new technologies of



information and communication acquiring an increasingly important role in all fields. It became evident that providing students with the entrepreneurial skills and abilities enabling them to deal with life's challenges and an uncertain future, which had always been a desirable target, had turned into an urgent need; since then that need has become even more acute. Undoubtedly, in any economic climate, adopting an innovative approach to problem-solving, adapting more readily to change, becoming more self-reliant and developing creativity through the study of entrepreneurship can yield far-reaching benefits. It could be argued, therefore, that the need for entrepreneurship education and training has never been greater [6].

The authors were, from the outset, aware of certain constraints. Chief among these were the absence of any institutional mandate and a lack of any previous experience of issues related to entrepreneurship. In terms of student attitudes, it is worth noting that the demand for entrepreneurship training was meager. In contrast to the increasing demand reported elsewhere [7], students from this university showed little intention of becoming entrepreneurs and did not direct their studies towards that goal. By the same token, academic staff needed an injection of motivation and enthusiasm.

Given these initial conditions, and resolved to explore new ways of operating in unfavorable environments, an itinerary for entrepreneurship education was designed. Entrepreneurship education programs seek to achieve a wide variety of aims. Hytti and Kuopusjärvi [8] proposed a conceptual schema: "(i) increasing understanding of what entrepreneurship is about; (ii) equipping individuals with an entrepreneurial approach to the 'world of work'; and (iii) preparing individuals to act as entrepreneurs and as managers of new business." The itinerary/program presented here was not intended to address the whole of this threefold division, yet it proved difficult to fit it into only one of the three categories. The program sought to bring about changes in student attitudes, to enable them to learn how to cope with complex and uncertain environments and to connect this approach to a substantial part of their university education. Although transforming an idea/opportunity into a venture was the guiding principle for the learning process, business creation was neither pursued in the short term nor ruled out; it was intended that students should acquire and practice new competences, enabling them to make their choice of professional development with greater insight.

This paper focuses on the evaluation of the program, which sought to identify the characteristics of an effective teaching-learning action with a view to fostering entrepreneurial attitudes in agricultural engineering students in an unfavorable environment and to discuss the lessons learned. The method used for this evaluation is based on a participatory approach not hitherto employed in this field.

The paper is structured as follows: a) outline of the requirements of a state-of-the-art entrepreneurship education program, placing particular emphasis on the characteristics of programs in university contexts, their contents, methodology and evaluation; b) overview of the various components of the program/itinerary designed and of method used for evaluation; c) discussion of the



results of evaluation, highlighting the lessons learned and the practical implications; and finally d) presentation of certain conclusions.

### BACKGROUND

Available data point to an insufficient integration of entrepreneurship in the curricula of higher education institutions, and question the success of such integration [9]. Many case-studies in the literature focus on university contexts [10, 11] in which entrepreneurship courses are developed *ad hoc* and not included in ordinary studies. In Europe, the situation is even worse than in North America, because education systems are more centralized and depend on decisions taken at national level. This was viewed by Carsrud [12] as one of the reasons for the lower implementation of entrepreneurship courses in European universities. One of the main difficulties seems to lie in the rigidity of the curriculum, which is often an impediment to inter-disciplinary approaches. Furthermore, developing and delivering entrepreneurship is made significantly more difficult by the internal organizational structure of an institution. Faculties and departments tend to work quite separately, and a number of obstacles hinder the establishment of cross-disciplinary courses [9].

Several authors recommend that entrepreneurship programs should be shaped and implemented by institutional actors, or should have a well-positioned leader close to the university hierarchy, thereby guaranteeing commitment and support for integration, networks and financial resources. Menzies [13], for example, argues that the higher the position in the hierarchy, the greater the level of program efficiency. Examples of initiatives following this top-down principle are to be found especially in business schools, where entrepreneurship is included as part of their vision and mission.

However, this requirement is often hard to fulfill, and the need to run entrepreneurship programs is too urgent to brook the delays generally arising before entrepreneurship is considered sufficiently important by institutional actors. For that reason, some programs opt for a bottom-up approach, notable for its small scale, a certain lack of institutional approval, and the widespread utilization of voluntary resources [14, 15]. These characteristics make sense because, as noted by Brännback et al. [16], entrepreneurship itself is a bottom-up process, and this should be reflected in the procedures involved. In most cases, the initiative leader plays a crucial role. As reported by Standish-Kuon and Rice [17], numerous initiatives would not exist without the work of either a single individual or a small group of people. These “champions” may advocate institutional acceptance in the curriculum arena, in the structure of the program, in financing, or in some combination of these areas. Critics argue that the field is weak because these programs hinge on the drive and determination of a single person. Kuratko [18], however, considers this to be their strength, arguing that it is an



authentic tribute to the commitment that exists within the entrepreneurship field. Furthermore, these initiatives are often undertaken in adverse environments. As Testa [14] points out, they may suffer from a “not-invented-here” syndrome, i.e. the tendency towards scarce collaboration in initiatives promoted by others, widely encountered in institutional contexts; this is especially important given that continuity over time is the main obstacle to be overcome.

Another feature of entrepreneurship courses is that most are aimed at business students and, even within science and engineering faculties, most existing programs have been run under the auspices of business schools or economics departments. However there is strong evidence [17, 19, 20] that more and more entrepreneurship programs are emerging for non-business students.

Brand et al. [21] considered that this expansion to include non-business students makes good sense. Among other reasons, non-business students possess domain-specific knowledge deemed important for the recognition of business opportunities and for increasing the perceived self-efficacy of the potential entrepreneur [5]. Another factor underlining the importance of entrepreneurship education for non-business students is their lack of awareness of the potential of business start-ups as a career choice [22], meaning their intention to start a business venture might be influenced more dramatically. Finally, non-business students, and especially those with an engineering background, are familiar with innovation and new product development, which gives them the potential to start high-growth technology ventures.

With regard to learning and training methodologies, there is no consensus on “how to teach” or on which methods are most suitable. Anderson and Jack [23] argue that entrepreneurship education is a difficult area on which to lecture owing to its variability, complexity and contingency.

A literature review of Mwasalwiba [7] revealed that most authors classify teaching methods into two groups: “traditional methods” (comprising normal lectures) and “innovative methods” (which are more action-based), also known as “passive methods” and “active methods”, respectively.

Scholars seem generally to agree that traditional methods are less effective in encouraging entrepreneurial attributes, although they might be useful for providing students with the commercial basis for their entrepreneurial actions. Yet other approaches, in which students are involved in real business contexts and have an opportunity to question, investigate, interact and talk to real-world entrepreneurs, and in which the learning process is essentially learning-by-doing or experiential, provide both knowledge and skills while also stimulating new attitudes [24, 25].

At the same time, a number of authors argue that emphasis on active approaches should not come at the expense of theory. Fiet [26], for example, advocates increasing the theoretical content in order to develop the cognitive skills students need to make better entrepreneurial decisions.



In a practical sense, most “active methods” are labor-intensive and costly, and may not fit in well with the conventional university teaching system. This may explain why, although viewed as effective and appropriate methods, they are not the most widely used in university contexts [9].

Many authors have drawn attention to the importance of learning based on real-life situations, because this approach obliges students to investigate the factors underpinning a business situation and to work in partnership with stakeholders [27], and it also gives students a chance to assess their abilities and make and note their own mistakes [28]. Accordingly, the teachers’ function should change: they are called upon to play the role of catalyst and facilitator, whose job is to help students to learn a new way of thinking. Instead of simply transferring content, they must now help their students learn how to think in entrepreneurial terms [29].

Psychology is especially important in programs that seek to promote a change in attitudes and intentions – as in the present case – in that it provides both theoretical and methodological support. The most widespread theory is that of planned behavior [30] which argues that planned behaviors (such as entrepreneurship) are intentional and thus are predicted by intentions towards that behavior. In turn, intention is best predicted by attitudes, which may be affected by exogenous influences. Therefore if entrepreneurship education is considered an exogenous influence [31], it may affect attitudes and, indirectly, intentions and behavior. This psychological component of entrepreneurship education adds complexity to the discipline and involves emotional elements that teachers need to consider not only for teaching the entrepreneurship curriculum but also with a view to prompting a change in ‘hearts and minds’ [31].

All this complicates the evaluation of programs and of students’ learning. In general terms, the real effects of entrepreneurship education are not yet known, and rigorous research into the impact of entrepreneurship education on learning outcomes is required [32, 33]. There appears to be no standard methodological approach to evaluation, nor is there a common set of evaluation criteria for determining effectiveness [34].

Several authors suggest that the best way to evaluate a training course on entrepreneurship is to establish a direct link between the outcomes of the program and its objectives [35, 36]. Most studies attempting to measure a change in students as a result of attending entrepreneurship training use the number of companies created by graduates as an indicator. A second indicator concentrates on the students’ academic performance [37]. A third group of indicators is associated with psychological constructs, such as change in students’ attitudes, perceptions, interests, self-efficacy, confidence, abilities and entrepreneurial skills [31, 38, 39]. For this last group, most impact assessment studies ranged from simple surveys of participants and trainers to longitudinal surveys of participants (i.e. a questionnaire administered at the start and at the end of the course), while others make use of control groups plus some qualitative interviews or focus group discussions [7]. The method used here, allied to these latter techniques, is based on a participatory approach not hitherto employed in this field.



## ITINERARY PROPOSAL

The need to find a model of an entrepreneurship learning program, adapted to the context of the authors' university, led to a very practical approach, with direct communication among the actors involved and a continuous process of experience and information feed-back. The procedure used was similar to educational research approaches labeled "Design Research" by van der Akker et al. [40] and characterized as: "interventionist (the research aims at designing an intervention in the real world), iterative (it incorporates a cyclic approach of design, evaluation and revision), process-oriented (a black box model of input-output measurement is avoided; the focus is on understanding and improving interventions), utility-oriented (the merit of a design is measured, in part, by its practicality for users in real contexts) and theory-oriented (the design is, at least partly, based upon theoretical propositions; and field testing of the design contributes to theory building)."

A learning itinerary was designed that followed these principles, as well as being based on a broader review of the literature and on the academic staff's own teaching experience. To enable inclusion of the intervention in the degree curriculum, the itinerary was based on an existing module (a subject matter which was already included in the curriculum). This module was modified and re-structured in terms of content and learning methodology, and then linked to two other existing elements: a training period or internship in an enterprise and the professional work required to complete the studies.

### The Elective Module: The Core of the Itinerary

This consisted of a program, implemented as a 4.5-credit elective module (45 hours of teaching), organized as follows:

- Plenary lectures which included: initial presentation session, teamwork learning sessions, sessions for business plan development and others.
- Tutorship-consultancy sessions in order to ensure an individualized approach for each group or student (progress assessment, difficulties encountered, ongoing results, training needs and so on).

The learning process was based on the drawing-up of a work project in which the different steps were tackled: generation of ideas, selection of ideas with business potential, product development, communication and business plan development, economic and financial plan development.

First, each student proposed three ideas. Then he/she evaluated and discussed the ideas with the course staff in order to highlight potential strengths and weaknesses and choose the most feasible. Afterwards, students divided into teams of two or three and each team decided whether their work project stemmed from an individual idea or from a new idea made by contributions from each team component.



Professors and specialists monitored the whole process, adopting a supporting and facilitating role in the choice of the most feasible idea, in team formation and in following steps.

A cooperative learning unit was provided in order to facilitate teamwork. Aspects related to this topic and also techniques for time management, communication abilities and solving problems and conflicts were included in this unit.

Open oral presentations of final projects were used to assess student learning. The evaluation committee was made up of professors, staff and entrepreneurs participating in the tutorship and consultancy sessions, and also by foreign specialists who enriched the discussion and projects.

During the itinerary, students were also encouraged to participate in competition of ideas, forums and entrepreneurial meetings.

### **Training Period in an Enterprise**

The training period or internship had been included in the ordinary curriculum of agricultural engineering as a learning element with a view to enhancing employability. In linking this component to the itinerary of the entrepreneurship program, the aim was for students to carry out the training in an enterprise within the field and economic sector of their business projects. This would enable them to obtain a wider perspective, focusing not only on technical aspects but also on business and management questions. It was also intended that students should make contact with potential suppliers, customers, banks, competitors and other entrepreneurs in the field.

### **Professional Work Required for Completion of Studies**

This step constituted the students' first piece of undergraduate professional work. It was linked to the itinerary, in order to enable students to expand the relevant sections of their business plans or the technical aspects necessary for the development of their business idea.

## **METHODOLOGY**

In order to ensure that the itinerary had been implemented as designed, and to identify aspects enhancing students' entrepreneurial attitudes and analyze the results of the initiative, formal assessments were conducted at the end of each edition based on Participatory Rural Appraisal (PRA) methodology. This is a social and participatory research approach, mostly used for development actions from the eighties. In this field, and in that of agricultural education and extension, participatory approaches are widely used; several authors have argued that they are an aid to gaining explicit and implicit knowledge [41] and that the use of qualitative evaluation





methods and 'soft' systems approaches are useful for traditionally perceived 'difficult-to-measure' advances in learning [42].

The use of PRA involves the implementation of a set of techniques based on semi-structured interviews, group interaction, triangulation, participant observation, hermeneutic interpretation and, especially, the joint visualization of information [43]. All these techniques enable information to be extracted and proposals to be agreed by all the actors involved. This methodology was chosen because, in general, as stated above, participatory techniques enable a better understanding of what students experience, seeking explanations for their behavior and generating a deeper knowledge of causes and effects. Compared to other participatory methods, PRA makes it easier to search for potential consensus; it enables the empowerment of participants as well as ongoing feedback, and generates commitment among all the actors involved. Written questionnaires or surveys, even those using open-ended questions, were avoided, because they were felt to be less likely to provide the type of in-depth reflective data required to fully benefit from the students' experiences [44].

For the purpose of conducting assessments, all students and academic staff were summoned for a day and a half over a weekend in the relaxed atmosphere of an off-campus location. The economic and time costs of the evaluations could be addressed only during the first four editions of the program. In later editions, information and conclusions were also extracted based on continuous interaction with the groups and with individual students. The total number of students participating in the ten years of the project's existence stands at 127. In the four evaluations performed with PRA methodology, the number of students was 14, 13, 11 and 10, respectively.

Each year, a specific timetable was designed for the evaluation (see table I).

The first two editions were aimed at fitting the schedule of the elective module; the latter two were designed to delve deeper into specific topics of interest. Detailed explanation of all the activities organized would take up too much space, so only the main techniques employed are described. In order to obtain a consensus of the entire group, most activities were conducted at three levels: individual reflection, discussion in small groups and finally whole group discussion. Examples of the techniques used are described below.

- Attitude chart. Objective: the identification of elements with the greatest impact and influence on entrepreneurial attitudes from the beginning to the end of the itinerary.
  - Each student drew up a graph representing the level of his/her entrepreneurial attitude (low, moderate or high) from the beginning to the end of the itinerary. Using Post-It notes, they were required to explain the factors underlying the rise, maintenance or decline in their attitude, indicating on the X axis of the graph the event involved (for example, "idea selection", "team formation", "project presentation", "participation of each expert" or "specific sessions").



| OUTLINE OF EVALUATION SESSIONS  |  |
|---|--|
| 1st Edition   | 2nd Edition  |
| Day 1<br>13.00: Departure<br>14.30: Lunch<br>16.00: Event presentation<br>16.30: Ice breaker game<br>17.30: Task 1: Attitude Chart<br>18.30: Break<br>19.00: Group discussion on favorable and unfavorable points for changing attitudes<br>19.30: Plenary and Temporal profile elaboration<br>21.00: Dinner<br>22.00: Task 2: Representation of business team functioning<br><br>Day 2<br>08.30: Breakfast<br>09.00: Task 3: Proposals for itinerary improvement<br>11.00: Break<br>11.30: Plenary, summary and recommendations<br>13.30: Event evaluation<br>14.00: Lunch | Day 1<br>13.00: Departure<br>14.30: Lunch<br>16.00: Event presentation<br>16.30: Task 1: Attitude Chart<br>17.30: Task 2: Role-playing (preparation)<br>18.00: Break<br>18.30: Role-playing (performance)<br>20.00: Debate<br>21.00: Dinner<br><br>Day 2<br>08.30: Breakfast<br>09.30: Valoration of motivating and demotivating elements<br>11.00: Break<br>11.30: Summary and Recommendations<br>13.30: Event evaluation<br>14.00: Lunch |
| 3rd Edition   | 4th Edition  |
| Day 1<br>13.00: Departure<br>14.30: Lunch<br>16.00: Event presentation<br>16.30: Task 1: Attitude chart/Temporal Profile<br>17.30: Task 2: Role-Playing (Preparation)<br>18.00: Break<br>18.30: Role-Playing (Performance)<br>20.00: Debate<br>21.00: Dinner<br><br>Day 2<br>08.30: Breakfast<br>09.00: Task 3: Rating entrepreneurial elements and comparison with other subject matters<br>11.00: Group discussion and Plenary<br>12.00: Break<br>12.30: Task 4: Proposals for itinerary improvement<br>14.00: Event evaluation<br>14.30: Lunch                           | Day 1<br>18.00: Departure<br>19.00: Event Presentation<br>20.00: Task 1: Attitude Chart/Temporal Profile<br>21.00: Dinner<br><br>Day 2<br>08.30: Breakfast<br>09.00: Task 2: Rating entrepreneurial elements and comparison with other subject matters<br>11.00: Group discussion and Plenary<br>12.00: Break<br>12.30: Task 3: Venn Diagrams for identifying agents of influence on students<br>14.30: Event evaluation<br>15.00: Lunch   |

**Table 1. Timetables and organization of the evaluation sessions.**

- As a guide, each student was given a schedule containing the main events from the start of the module, as well as guide questions. Once each student had completed the graph, he/she shared reflections with members of their business idea group. Finally, in a plenary session, all graphs were displayed and discussed. Complementary to this activity, a chart was drawn up with suggestions for improving motivational elements and reducing discouraging ones.



- Role-playing games. Objective: the provision of a space for expression and reflection on the emotional aspects of the initiative (group functioning, conflicts of interest -venture creation *versus* finalizing studies- and tensions at the academic and personal levels).
  - The students, divided into groups, acted out fictional situations in which a variety of roles were represented: people from academia and business (teachers, invited entrepreneurs), students (male and female, someone who wants to run a company, someone who just wants to pass the exams, etc.), various people from the students' immediate environment (family, partners, classmates, friends, etc.).
  - For each performance, one person was chosen to be the moderator. Each team was given guidelines to prepare their roles. They also had to prepare several arguments because they had to express their views but in addition provide ideas to reach a consensus on how to resolve conflicts of interest.
  - During the games, each group expressed its view and then held a debate, trying to reach a consensus facilitated by the moderator. After the role-play, results were discussed in a plenary session.
- Rating entrepreneurial elements. Objective: To assess whether the module had helped to develop entrepreneurial competence.
  - Each student was given a sheet with 12 elements identified in the literature as characteristic of entrepreneurs: 1) planning, organization and meeting deadlines; 2) ability to make decisions and take risks; 3) adaptability to change; 4) interest in innovation, changing reality; 5) interest in the business world; 6) resistance to frustration; 7) ability to search and find resources; 8) self knowledge; 9) ability to work, and perseverance; 10) ability to establish support networks and contacts, 11) motivation for achievement and completion of work; 12) self confidence. First they had to score themselves for each attribute before and after attending the module. Then they were organized into groups where they pooled information about three of the elements. At this point, for each element that had changed, they had to indicate the techniques, work or attitudes that had led to the change. Finally, the work done by each team was shared in a plenary session.

In order to gather all the information extracted throughout the sessions (key issues, strengths and weaknesses of the module, improvement proposals, and critical overview), which had been synthesized in a visual display and agreed by all participants in plenary session, at the end of each assessment a document was drafted and e-mailed to all participants. The document was agreed and endorsed unanimously.



## RESULTS AND DISCUSSION

Before examining and discussing the core results, some quantitative data are provided below to give an idea of the scale of the project.

After 10 years of running the program, the number of business projects totals 48. The topics addressed have mostly dealt with new technologies for the agri-food industry and service companies for engineering utilities, gardening, rural tourism, the livestock sector and so on. At the time of writing, although only three individuals are pursuing the business ideas developed during the program (it should be borne in mind that the participants were undergraduate students), a total of 16 active enterprises have been created by participants; this may be considered acceptable, given that the purpose was to bring about changes to attitudes rather than create start-ups.

In what follows, the results emerging from each edition's consensus document are set out, some of them being proposals made by students. These are summarized in four tables that focus on: curricular integration, content and methodology, motivational elements and personal considerations. An analysis and discussion of the results is then set out based on the insights gained from ten years' experience.

The information, analysis of results and feedback from each edition's students were used to obtain a schedule more adapted to the context, to achieve a deeper understanding of how and why the results were obtained, and to improve the professional performance of teachers. As far as the itinerary is concerned, major adjustments were made in terms of:

- Organizing sessions according to the needs of project progress, incorporating a high degree of flexibility and including sessions on topics requested by students;
- Improving the criteria for team building;

| Curricular integration  |   |  |  |
|---|---|--|--|
| 1st Edition   | 2nd Edition   | 3rd Edition  | 4th Edition  |
| <ul style="list-style-type: none"> <li>• There have been no similar experiments in the college and students criticize the lack of prior disclosure, with the consequence that they do not entirely understand what the itinerary involves.</li> </ul> | <ul style="list-style-type: none"> <li>• Students see the need to integrate other subjects into the work of the module.</li> <li>• They highlight a lack of encouragement and accompanying elements at university level.</li> </ul> | <ul style="list-style-type: none"> <li>• Students see the need to integrate other subjects into the work of the module.</li> <li>• Students perceive the module as a "very small" subject within the degree curriculum.</li> </ul> | <ul style="list-style-type: none"> <li>• Students demand more subjects linked to entrepreneurship within the degree.</li> <li>• They highlight a lack of encouragement and accompanying elements at university level.</li> <li>• They consider that more elements are required for workplace rapprochement.</li> </ul> |

**Table 2. Results of evaluations: curricular integration.**



| Contents and Methodology   |  |   |  |
|--|--|---|--|
| 1st Edition  | 2nd Edition  | 3rd Edition   | 4th Edition  |
| <ul style="list-style-type: none"> <li>• Students think the program is innovative. It favors the entrepreneurial spirit.</li> <li>• The schedule is not matched to the content.</li> <li>• Teamworking created conflicts in most groups.</li> <li>• The friendly and cooperative work atmosphere favors involvement and participation.</li> <li>• Training period in enterprises must be properly integrated.</li> </ul> | <ul style="list-style-type: none"> <li>• Students consider the workload excessive in relation to academic recognition.</li> <li>• Students demand better information on the development of the business plan.</li> <li>• Students consider that good team formation is key to smooth functioning.</li> <li>• Cooperative learning sessions are highly valued.</li> <li>• The module promotes the acquisition of skills and abilities. It helps students tackle the labor market better.</li> <li>• Tutorship sessions provide the learning process with flexibility for different working speeds.</li> </ul> | <ul style="list-style-type: none"> <li>• Students think the subject is interesting and innovative, but demands too much effort.</li> <li>• Students believe that contents and methodology are well organized for promoting entrepreneurship.</li> <li>• Students consider that good team formation is key to smooth functioning.</li> <li>• Business plan highly valued as a good tool for gaining the overview of the process.</li> <li>• Students demand better information on the development of the business plan.</li> </ul> | <ul style="list-style-type: none"> <li>• Students think the subject is interesting and innovative, but demands too much effort.</li> <li>• The methodology used promotes entrepreneurship.</li> <li>• Teamwork enabled students to develop skills.</li> <li>• Students detect the need to augment the economic and financial aspects of the business plan.</li> <li>• Training period in enterprises must be properly integrated.</li> </ul> |

**Table 3. Results of evaluations: contents and methodology.**

- Adjusting the pressure on students to make the itinerary compatible with other students' commitments;
- Consolidating acquired knowledge and reinforcing the weakest elements.

**Lessons learned**

1. Curricular integration provides legitimacy and recognition to the initiative and guarantees continuity over time.

The decision to design the initiative using elements already included within the standard agricultural engineering studies curriculum (mainly by changing the structure and orientation of a former subject) was a good way of guaranteeing its continuity and avoiding delays and difficulties arising from a rigid learning system resistant to the implementation of innovations.

One negative feature of the integration centered on limitations and timetables imposed by strict academic arrangements. The use of tutorship and consultancy sessions was a key aspect in solving these issues.

Another difficulty was that, in general, students did not visualize the whole itinerary and most of them focused only on the elective module. The intention behind the design of the whole itinerary was to ensure a certain degree of continuity between elements, and to give students a sense



| Motivation   |  |  |  |
|--|--|--|--|
| 1st Edition  | 2nd Edition  | 3rd Edition  | 4th Edition  |
| <ul style="list-style-type: none"> <li>• Ownership of ideas.</li> <li>• Personal contact with businesspeople and specialists.</li> <li>• Teachers involved with continuous support.</li> <li>• External recognition.</li> <li>• Negative effect of the lack of continuity at the end of program.</li> <li>• Business plans help students get a feel of reality.</li> <li>• Significant impact on the media.</li> </ul> | <ul style="list-style-type: none"> <li>• Personal contact with businesspeople and specialists.</li> <li>• Teachers involved with continuous support.</li> <li>• External recognition.</li> <li>• Negative effect of the lack of continuity at the end of program.</li> <li>• Business plans help students get a feel of reality.</li> <li>• Teamwork.</li> <li>• Progressive and ongoing work to achieve small successes.</li> </ul> | <ul style="list-style-type: none"> <li>• Ownership of ideas.</li> <li>• Personal contact with businesspeople and specialists.</li> <li>• Teachers involved with continuous support.</li> <li>• External recognition.</li> <li>• Negative effect of the lack of continuity at the end of program.</li> <li>• Teamwork.</li> <li>• Self-learning.</li> </ul> | <ul style="list-style-type: none"> <li>• Ownership of ideas.</li> <li>• Personal contact with businesspeople and specialists.</li> <li>• External recognition.</li> <li>• Existence of a joint working space.</li> </ul> |

**Table 4. Results of evaluations: motivational elements.**

of being supported at various points of the process. However, students experienced what they considered to be a high workload, with demanding objectives and content. In fact, few students completed the itinerary and few viewed the creation of their own business as a potential first job, something that might otherwise have encouraged them to intensify their efforts during the other elements of the itinerary.

2. The bottom-up approach is useful at the outset but insufficient to change an adverse environment

In general, participants felt that the scale of the program was too small to enable important changes to be achieved. Indeed, the initiative is far removed from other programs that were born under the leadership of the university hierarchy and have had from the outset sufficient size and resource availability. This lack of an entrepreneurial context within the university was detected by

| Personal considerations   |   |   |   |
|---|---|---|---|
| 1st Edition   | 2nd Edition   | 3rd Edition   | 4th Edition   |
| <ul style="list-style-type: none"> <li>• It is a life experience that goes beyond the teaching and academic field.</li> <li>• Significant family influence.</li> <li>• Strong divergence between finishing studies and moving toward venture creation.</li> </ul> | <ul style="list-style-type: none"> <li>• Personal maturing process, self-knowledge and autonomy.</li> <li>• Family pressure to finish studies.</li> <li>• Fear to failure.</li> </ul> | <ul style="list-style-type: none"> <li>• Feelings of personal satisfaction.</li> <li>• New way of acquiring knowledge.</li> </ul> | <ul style="list-style-type: none"> <li>• Personal maturing process, self-knowledge and autonomy.</li> <li>• Significant family influence.</li> <li>• It sharpens the senses.</li> <li>• Significant improvement of networks.</li> </ul> |

**Table 5. Results of evaluations: personal considerations.**



students who pointed out that they had experienced two different environments: on the one hand, poor entrepreneurial motivation throughout the course of their regular studies at the university; and on the other hand, a contrasting situation where, thanks to the program, they were involved in competitions, forums and entrepreneurial courses where all conversations revolved around entrepreneurship and business ideas.

The authors concur with the students in feeling that most subjects and modules in agricultural engineering need to be involved in order to achieve really effective change. By the same token, it would be useful to obtain at least a minimal degree of entrepreneurial commitment from academics teaching other subjects. This seems to be confirmed by the experience at other institutions [15] where, by means of an integrated academic program containing several connected elements, they have apparently succeeded in establishing a solid and complete academic offering for undergraduates.

With the aim of extending the initiative throughout the curriculum, the organizers tried to engage other academics who were not directly connected to the program. They were involved especially when students asked them for technical assistance to make headway with their products and ideas. By supporting the initiative with this activity, the academics felt themselves to be part of the process, thereby rediscovering and improving their commitment and motivation. However, a system for incorporating a larger section of the academic community needs to be consolidated.

The integration of entrepreneurs (most of them alumni) as invited speakers and “teachers” was another important element that was reinforced. With the task of involving all these actors and connecting them with students, the role of the initiative leader, inspiring and spreading enthusiasm among participants and staff, was critical, as in other bottom-up approaches [14, 15].

### 3. Authentic learning requires more resources than traditional subjects, but in turn opens doors to new contacts and sources of funding

Financial issues were also a key aspect. It is clear that a model that enables students to learn in an environment similar to real entrepreneurial life requires more resources than ordinary subjects. This is especially important for the long-term perspective and has previously been pointed out by Pittaway [45]: “the more established the funding sources of entrepreneurship education, the greater the chance entrepreneurship education has of becoming embedded, and ultimately valued, in the local context”.

It became evident that in order to address all these issues and achieve a sustainable program, it is essential to consolidate a network where all actors are capable of benefiting, and in which contacts, supports, financial issues and so on are given priority. To that end new strategies have to be sought, complementing “bottom-up” approaches with those “top-down”, as has been suggested by others [9].



Anyway, implementing the initiative enabled the authors to contact non-educational institutions with resources to support entrepreneurs (business incubators, technical advisory agencies, financing programs and so on) which were accessible to students, both during the completion of the itinerary and for those who decided to continue with their entrepreneurial project.

4. In all the elements comprising the program, a common pattern was identified underlying students' motivation: authenticity and the approach to real life.

Other authors have focused on the relevance of authentic learning as a conceptual framework for education in entrepreneurship [46], and it has rightly been pointed out that a realistic approach is the key to success in entrepreneurship education [27]. The present authors agree and found that the process is so experiential that if it is not authentic, its usefulness considerably decreases. It is thus advisable to make students experience what being an entrepreneur means and so favor the sense of real life. It became clear that utilizing authentic learning enabled students to interact with the business world, providing them with the chance to compare ideas with specialists, the possibility of acquiring new vocabulary, sharing out work, and so on.

The following purpose-designed elements helped to reinforce this sensation of reality:

### **Co-Working Space**

An entrepreneurial space was placed at the students' disposal that served as their office, enabling meetings with other teams to discuss common elements of their business ideas, "refreshing" their motivation and open to all students. This space proved to be, on a small scale, an innovative and creative environment where entrepreneurs worked with peers, where their activity was appreciated and they were able to infuse other students with their motivation. This supports the findings of other authors, who highlight the importance of an empowered environment where students can develop their ideas, test their own capabilities and build the required self-trust [27].

It was confirmed that peers play an important role in entrepreneurial reflection and learning, as well as in the emotional conflicts associated with entrepreneurship, learning from others being one of the proven characteristics of entrepreneurial learning patterns [46].

### **Making Their Own Decisions: from Ideas to Business Model**

The aim was to help students appreciate that idea generation and subsequent evaluation is a common process to which entrepreneurs must subject themselves, so that it did not come as a subsequent revelation. This is why after a briefing about how and where to look for innovative ideas in the field of agribusiness, students were asked to, individually and in a week, identify three business opportunities within the scope of their personal interests, and then select the one they thought had the best chance of success. It was important that students





were interested in the topic, and considered themselves as idea developers, since this enhanced their self-confidence.

Although some literature deals with the importance of intuitive decision-making [47], the authors' experience is that, even without this feature, any idea, after preparatory work well done, can lead to a business opportunity.

A key aspect is the role of academic staff in supporting the idea re-orientation process, from the initial proposal to a real business opportunity. The intervention of teaching staff is essential in order to speed up all steps of the process. Since everything had to be completed in approximately four months, it was crucial to facilitate the search for innovative technology and solutions to increase the viability of the project. The critical point here was finding a good balance between the independence and autonomy of participants and the need for guidance and feedback. Aware of the importance of maintaining students' sense of ownership of their ideas [46], staff permitted some erroneous decisions to be taken despite the fact that this made the process longer.

At other times it was necessary to suggest considerable changes to the original idea in order to bring about a tipping point in motivation. When students started seeing the potential of their idea, their enthusiasm was rekindled and they made a great deal of progress by researching new technologies and studying in depth.

### **Focus on Technical Development**

Since students feel more confident in technical fields than in business, special emphasis was placed on the drawing-up of the technical dossier. Consolidating and making progress on their technical products enhanced students' self-confidence and autonomy. The comparison of their products/services with those produced by real enterprises made them identify opportunities for business in a sector where they feel competent.

Generally speaking, the result of the authors' experience was that engineering students took advantage of their technical learning, improved their background in areas where they had shown special interest, and identified gaps in their knowledge to be covered by a choice of subjects, completing their technical training for possible business venture creation or employment searching in a certain area.

The importance of this orientation has also been underlined by other authors. Testa [14] reported that when research-based ideas as well as ideas for growth-oriented business were absent, the resulting projects were often more didactical exercises rather than real business opportunities. Pajarinen et al. [48] noted that successful entrepreneurs were more often those who use modern business models and base their ventures on new technology.

**“Just-In-Time” Information Approach**

The learning context also confirmed that the best way to absorb theoretical concepts was through practice and precisely at the moment they were needed. It was especially effective to provide the concepts students needed to make progress with their business ideas (technical aspects, marketing, commercialization, finances, economic evaluation and so on) once each group had already tried to address the step involved. This “just-in-time” approach to the providing of information [49] was very well received and went down better than sitting through hours of traditional classroom training. It helped students solve problems, perform specific tasks and quickly update their skills. Similar results were reported by Nab et al. [46], who used this finding to adjust their procedural approach and link this issue to the need-to-know principle [50].

**Use of Business Plan as Road Map**

The present authors are aware of the debate concerning the use of business plans. Some commentators consider them, together with case studies and contact with entrepreneurs, as the main teaching tool in entrepreneurship, since they require the formalization of business ideas and increase the perceived self-efficacy of the potential entrepreneur [51]. Others question whether business plan development is a good model for entrepreneurial behavior; Gibb [52], for example, argues that business plans are a tool for financial agents rather than for entrepreneurs. He also suggests that excessive focus on the business plan may inhibit the entrepreneurial response to subsequent changes in the environment [53].

Here, the use of business plan was successful in the sense that it provided the basic outline and helped in ordering content. It provided a convenient approach to the process, obliging students to maintain a constant overall view of the project and everything necessary to run it, while identifying those aspects that needed to be studied in depth. It also entailed sorting ideas and evaluating the decisions to be taken for the business design.

There was limited time to address the business plan in depth and students found some difficulties in preparing their economic studies, but in general, they came to appreciate the necessity of behaving in an entrepreneurial way, maintaining close contact with real life, establishing contacts with real suppliers, sounding out potential customers, placing special emphasis on all technological development and marketing aspects. All these tasks contributed to creating an “aura of formality and conviction”, to borrow Honig’s [51] expression, which helped increase students’ perceived self-efficacy.

**Participation of Entrepreneurs And Practitioners.**

Students valued entrepreneurs as invited speakers as one of the most motivating initiatives in the program. Although some commentators oppose it because of the risk of transmitting knowledge and



experience based on “war stories” and anecdotes [54], the results of the current authors’ experience are similar to those authors who argue that invited speakers can play an important role as mentors, introducing the new entrepreneur to local business circles [55]. In this regard, students reported that listening to what is involved in the day-to-day life of an entrepreneur made them reflect on their personal and career-related goals. It was also easier to project themselves into the position of alumni who become entrepreneurs rather than imagining becoming well-known and successful entrepreneurs.

The participation of entrepreneurs operating in the same field as the students’ ideas was especially useful, in that they provided a particularly practical vision and helped students to focus on critical points. Contact with entrepreneurs also had important emotional effects: sometimes contributing to idea maturation and at other times provoking crises leading to idea reorientation. All comments and opinions from entrepreneurs about students’ business ideas were highly valued and welcomed.

### **Working in Teams**

In general, teamwork yielded positive results, fostering cooperative rather than competitive attitudes. Other commentators have reported that teamwork learning enhances student performance [56], and the present authors found that it enabled students to practice such skills as negotiation and effective communication. It favored self-knowledge by enabling analysis of students’ own behaviors and those of the group, as well as identifying roles and tasks. It was also useful in simulating real-work environments where social skills were practiced.

The specific learning module on teamwork was appreciated by students because it provided them with tools they could apply immediately. As a practical exercise during these sessions, students drew up the mission statement for the course. It prompted a process of self-reflection and was a key aspect in achieving a cooperative working environment among all actors, facilitating students’ active participation and generating commitment and personal satisfaction with the goals attained.

Team formation required special attention, with particular care being devoted to ensure the following features: (i) individual business ideas had to generate a collective idea, within the personal interest areas of all group participants and maintaining the sense of ownership among them all, (ii) a good balance had to exist between the interests, personal and academic situations, and expectations of each group participant, enabling a uniform working pace within the group. These premises were necessary in order to avoid situations where the group-based learning method might otherwise lead to poor student performance, such as in cases involving dysfunctional teams [57], lack of communication within the team or lack of authenticity of the assignment [58]. For example, students sometimes had to abandon a part or the whole of their idea in order to be included in a team, a



situation that often led to frustration and discouragement. In such cases, experience showed that it was better to sacrifice teamwork and favor the development of the individual idea.

### **Combining Plenary Sessions with Tutorship**

The combination of plenary sessions, where issues of common concern were addressed, with individual/team tutorship enabled a better utilization of resources (especially the participation of entrepreneurs and practitioners) as well as personalized monitoring.

Tutorship is spreading in entrepreneurship education, as a type of individualized attention capable of stimulating the intellectual growth of students [59]. In the present initiative it was highly valued by students, and tutorships were established as mandatory rather than voluntary. They enabled participants to tackle the wide range of objectives and contents with the required flexibility in timetables and in working speeds as well as differentiating approaches to each team according to their availability and commitment. Furthermore, as Mwasalwiba [7] has pointed out, students enroll on courses for a number of different reasons resulting from a host factors, with the consequence that it is not possible to design specific courses for each student, but the flexibility of tutorships enables them to be adapted to specific demands (taking them from a mere learning exercise to actual venture creation).

As tutorships make heavy demands on time, it is important that the work to be performed in each type of session is properly distributed, that other monitoring systems such as inquiries by e-mail are included, and that other teachers specializing in the project topics are involved.

### **Entrepreneurship Education Requires a Radical Change in the Traditional Role of Teachers.**

In a process that promoted self-learning, the teachers' traditional role as suppliers of information and knowledge was rendered meaningless. What became clear was the importance of establishing a close and constant bond with the individual student (or group). Results from the evaluations showed that students' entrepreneurial attitudes fluctuated over time (see Figure 1, for results of the "attitude chart/temporal profile" task). For instance, team formation was in general motivating; the first tutorship session was critical because many students reacted badly when their collective business idea was criticized; project presentations provided a sensation of reality and satisfaction with the work done; the choice of enterprise for in-house training was only motivating if it was well-adapted to the business idea developed in the module. Therefore a process of continuous encouragement was identified as a key aspect in keeping motivation high. A support program throughout the whole process required teachers to act as coaches (facilitating the students in discovering answers and new behaviors for personal growth and professional advancement), and mentors (involving informal communication, usually face-to-face and during a sustained period of time for the transmission of knowledge and psychosocial support [60]).

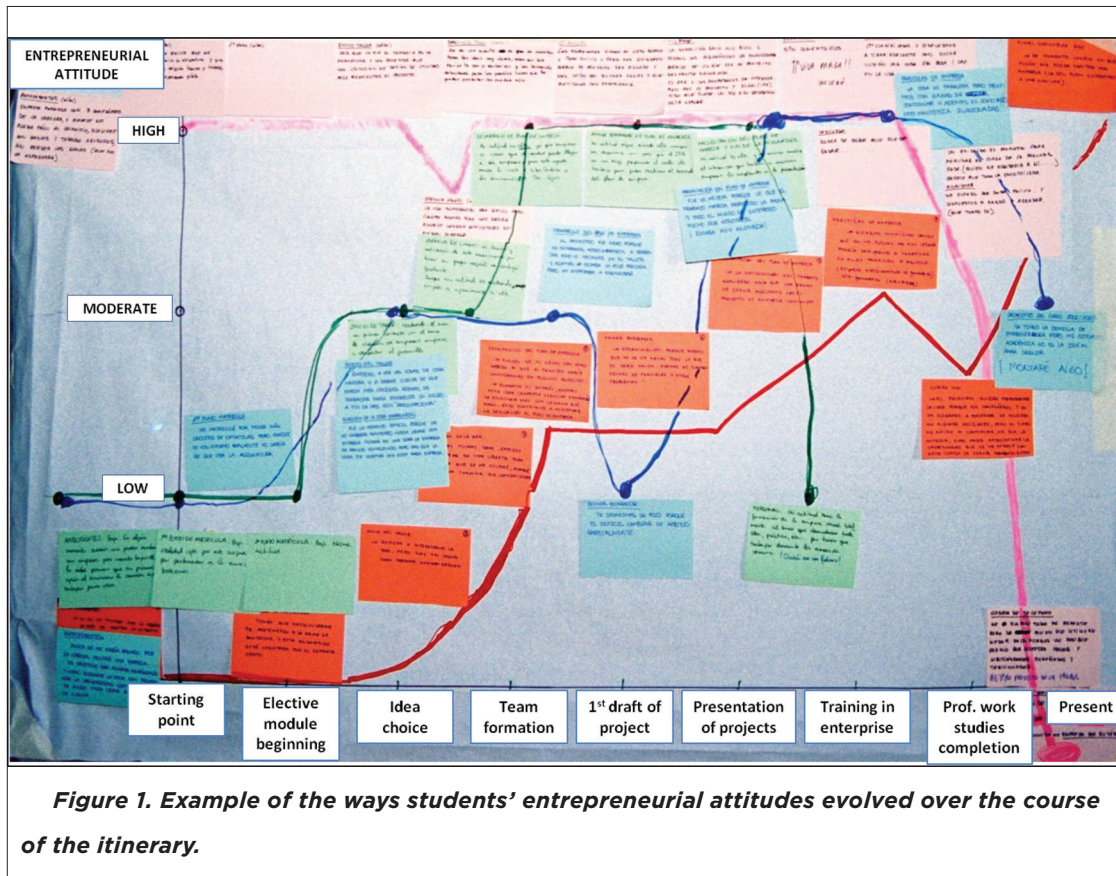


Figure 1. Example of the ways students' entrepreneurial attitudes evolved over the course of the itinerary.

**Methodology and Contents Improve Entrepreneurial Competence**

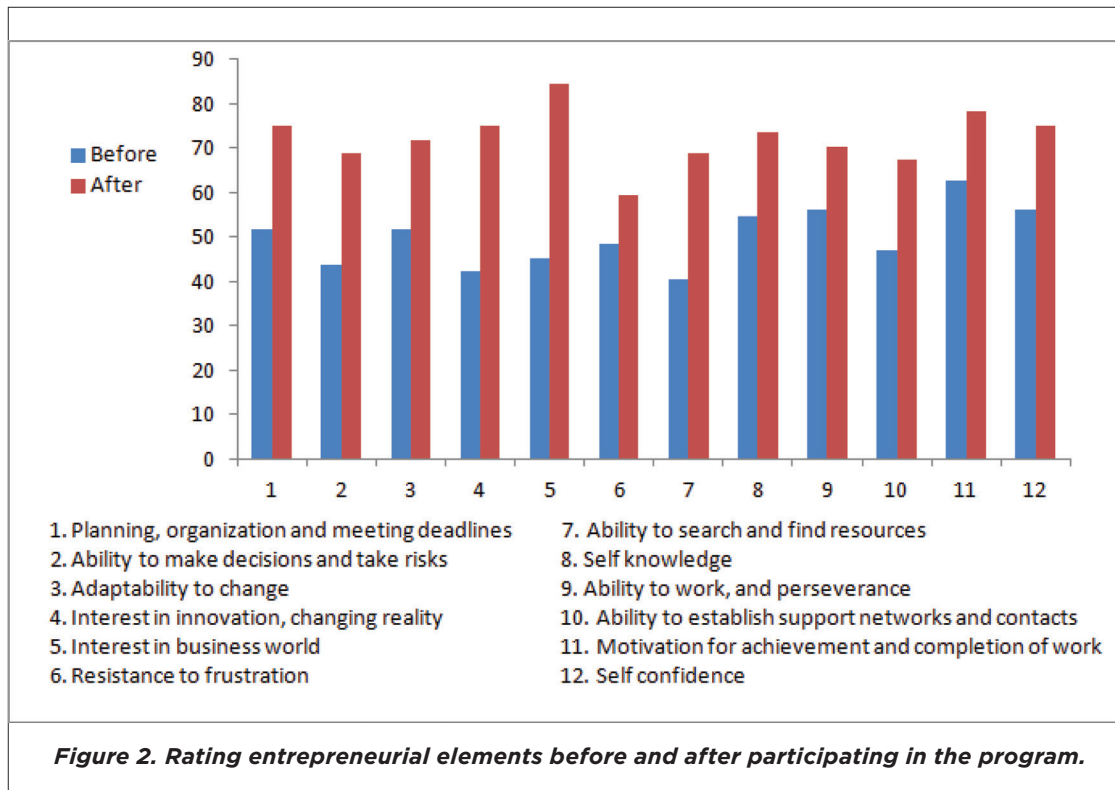
As part of the evaluation sessions, and after various exercises involving reflection, students were asked about the changes observed in their entrepreneurial competence and how they took place. In all cases, students recognized that the experience had a positive impact on the main entrepreneurial elements. When these were quantified before and after the program, all of them exhibited an increase (Figure 2). The smallest increments were found for “Resistance to frustration” and “Ability to work, and perseverance”. This result may be explained by the fact that these elements had already been enhanced over the course of regular studies, especially by completing the most difficult subjects.

**Entrepreneurship Education Is Not a Straightforwardly Academic Subject - It Has an Impact at the Personal Level.**

An important finding to emerge from the initiative was its impact on personal and family considerations. Since they were attempting to change not only aspects of knowledge and background



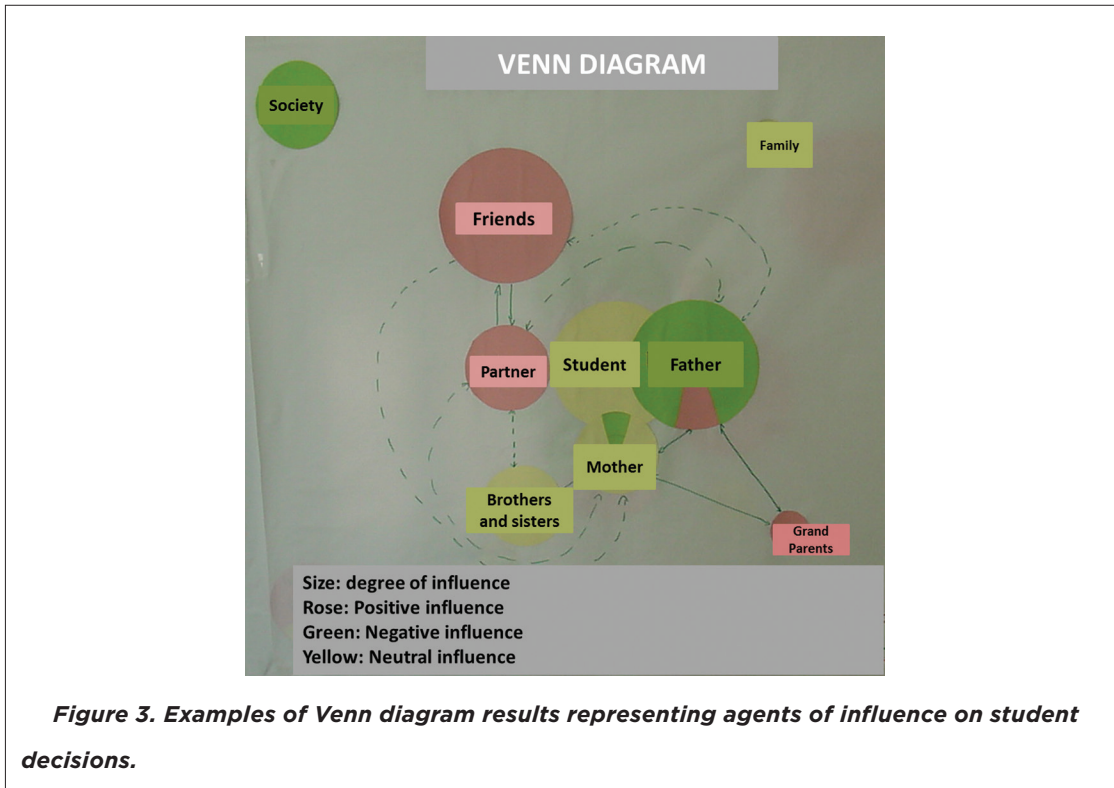
## Assessing an Entrepreneurship Education Project in Engineering Studies by Means of Participatory Techniques



but also behaviors and values, academic staff had to treat students in a holistic way. Therefore they also dealt with personal and emotional issues, which are rarely tackled by staff in university contexts. Clearly the workload and personal implication for the course staff was much higher than in other subjects. It resulted, however, in collective learning involving all participants in such a way that the greater degree of commitment helped to increase motivation and enthusiasm.

It became evident that the program went beyond ordinary knowledge learning. It involved personal decisions and entered students' private environments in an integral learning context, influencing students' personal and professional maturing. In fact, there were conflicts of interest and emotional conflicts among students and between them and their social and family environments.

At the end of the academic year they were immersed in examinations and faced the dilemma of either finishing their studies or continuing with their business projects. During the first edition, venture creation was pursued with more emphasis, generating a high level of anxiety in students. Therefore in subsequent editions the focus changed, and transforming an idea into a venture was only used as a guiding principle of the learning process, although the possibility of venture creation remained open.



Parents were identified as the people with the highest influence on students' decisions (see Figure 3 for examples of Venn diagrams identifying agents of influence). Most of the time parents tended to play a "protective" role. They encouraged their offspring to finish their studies and search for a job in a well-established company or in the public sector. These results are in line with surveys performed by the Spanish center of sociological research according to which only 8.1% of Spanish parents recommend their children to choose entrepreneurship as a first career option [61].

Some commentators have already suggested that entrepreneurship education may have to address other factors, such as the prospect of student-family conflict [62]. In the present initiative, the program's external impact in terms of participation in competitions and forums for entrepreneurs as well as publications of program events in the local press had a positive effect in changing families' minds.

The authors believe that the opportunity of entering into that personal level and helping students to make hard decisions is a great responsibility, but that it also constitutes one of the program's strengths.



### CONCLUSIONS

This study represents a contribution to entrepreneurship education within a non-business subject area, showing that it is possible to integrate into the curriculum of an agricultural engineering degree a specific itinerary that promotes entrepreneurial behavior.

Despite being a small-scale initiative, developed in an adverse context (in terms of the lack of institutional support and meager student demand), it has proved to be a useful activity for changing attitudes and improving entrepreneurial competence in undergraduate students.

The small-scale intervention has been useful, as a first step, for both teachers and the institution. It has enabled experience to be gained in incorporating entrepreneurial competence, reinforcing key aspects of student motivation and understanding the implications that this type of training has at the personal level, in a way that differentiates it from the teaching of regular technical subjects. It is important to be aware that it is possible to instill in students a significant degree of motivation, appreciation of work well done and the attainment of objectives. However, the need to help students visualize the whole itinerary, and not only the elective module, soon became evident. This visualization effort should also be aimed at the rest of the institution and other stakeholders.

The research methodology used, with iterative cycles of testing and refinement of solutions in practice, enabled the organizers to adjust the itinerary to the characteristics of the context. PRA methodology proved extremely useful for the purposes of program evaluation, enabling core motivations to be identified; in particular, it helped to foster students' personal commitment to the project, because they felt themselves to be part of the reflection process shaping the implementation of entrepreneurship in their department.

On the basis of these results, the key elements to be incorporated into any training program aimed at increasing entrepreneurial competence are: (i) an approach firmly rooted in reality, engaging with real life; and (ii) constant mentorship and support for students.

The main constraints identified were: (i) the fragility of the initiative, owing to its dependence on the organizers; (ii) the heavy demand placed on the commitment and availability of teachers, and the increased workload associated with this type of training; (iii) the need for changes to the traditional system of teaching and learning (both by teachers and students), whereby the acquisition of knowledge and the imperative to pass exams is replaced by learning to think and behave in an entrepreneurial way.

All these lessons have been taken on board and stand the authors in good stead for identifying and addressing new challenges. One of the most significant opportunities to improve the usefulness and impact of the itinerary lies in linking the initiative to other subjects within the degree. Therefore, looking to the near future, efforts should be made to secure the commitment of as many teachers as possible in order to establish an "entrepreneurial ecosystem" that brings together a range of stakeholders and draws on very different ingredients, from the psychological and emotional to the technical and financial.





Another prospect that has emerged, suggesting a direction the project may take in the future, is testing the feasibility, applicability and adaptability of lessons learned to other contexts. At present, the authors are involved in an international project with Latin-American and other European universities in promoting entrepreneurship education as a means of encouraging social and economic development and combating social inequality, which may represent an opportunity to widen the scope of the initiative, sharing and complementing experiences with other higher education institutions.

The results of this research may be helpful to other academics and agents within the field of education contending with non-favorable environments and a mixed awareness of the need for entrepreneurship education. The experience presented and the need for entrepreneurs encourages the authors to recommend taking the risk, even when conditions are not entirely favorable.

## ACKNOWLEDGEMENTS

The authors are grateful to Ms. Gema Sánchez-Úbeda for her assistance with the elective module sessions and evaluations. The authors are grateful to the associate editor and reviewers for their valuable comments, which have been of immense help in improving the manuscript.

## REFERENCES

1. Ohland, M.W., Frillman, S.A., Zhang, G., and Miller III, T.K., "NC State's Engineering Entrepreneurs Program In The Context of US Entrepreneurship Programs", *Education that Works: The National Collegiate Inventors and Innovators Alliance (NCIIA) 8th Annual Meeting*, March 18-20, (2004).
2. Torres, M.A., Velez-Arocho, J.L., and Pabon, J.A., "BA 3100—Technology-Based Entrepreneurship: An Integrated Approach to Engineering and Business Education," *Proceedings, IEEE Frontiers in Education 27th Annual Conference 2* (1997): 738-743.
3. Papayannakis, L., Kastelli, I., Damigos, D., and Mavrotas, G., "Fostering entrepreneurship education in engineering curricula in Greece. Experience and challenges for a Technical University", *European Journal of Engineering Education* 33(2) (2008): 199-210.
4. Confederation of EU Rectors' Conferences, Association of European Universities (CRE), "The Bologna Declaration on the European space for higher education: an explanation" (2000), <http://ec.europa.eu/education/policies/educ/bologna/bologna.pdf>
5. Liñán, F., Rodríguez-Cohard J.C., and Rueda-Cantucho J.M., "Factors affecting entrepreneurial intention levels: a role for education", *International Entrepreneurship and Management Journal* 7(2) (2011): 195-218.
6. Henry, C., Hill, F. and Leitch, C., "Entrepreneurship education and training: can entrepreneurship be taught? Part I", *Education and Training* 47(2) (2005): 98-111.
7. Mwasalwiba, E. S., "Entrepreneurship education: a review of its objectives, teaching methods, and impact indicators", *Education and Training* 52(1) (2010): 20-47.



## Assessing an Entrepreneurship Education Project in Engineering Studies by Means of Participatory Techniques

8. Hytti, U., Kuopusjärvi, P., "Evaluating and Measuring Entrepreneurship and Enterprise Education: Methods, Tools And Practices", Small Business Institute, Business Research and Development Centre, Turku School of Economics and Business Administration, 2004.
9. European Commission, Enterprise and Industry Directorate-General - Promotion of SMEs competitiveness - Entrepreneurship, "Entrepreneurship in higher education, especially within non-business studies. Final Report of the Expert Group" (2008).
10. Klofsten, M., "Training entrepreneurship at universities: a Swedish case", *Journal of European industrial training* 24(6) (2000): 337-344.
11. Edwards, L., Muir, E., "Promoting entrepreneurship at the University of Glamorgan through formal and informal learning", *Journal of Small Business and Enterprise Development* 12 (4) (2005): 613-626.
12. Carsrud, A., "Entrepreneurship and enterprise formation: a brief perspective of the infrastructure in Europe". *Entrepreneurship Theory and Practice* 15(3) (1991): 69-75.
13. The Atlantic Canadian Universities Entrepreneurship Consortium, "Part II. An Examination of Models, Best Practices, and Program Development" (2004).
14. Testa, S., "Establishing Entrepreneurship Education with a Bottom-up Approach: insights from a longitudinal case study", *International Journal of Entrepreneurship and Small Business* 10(2) (2010): 241-256.
15. Postigo, S. R., and Tamborini, M. F. "Entrepreneurship education in Argentina: the case of university of San Andrés", IntEnt Conference (2002), Malaysia.
16. Brännback, M., Krueger, Jr., N., Carsrud, A., and Elfving J., "Re-visiting the "Molecular Biology" of Regional Innovation Systems: Competing Models of Technology Development", *Proceedings of 2008 United States Association for Small Business and Entrepreneurship (USASBE)* (2008): 1108-1132.
17. Standish-Kuon, T., and Rice, M.P., "Introducing Engineering and Science Students to Entrepreneurship: Models and Influential Factors at Six American Universities", *Journal of Engineering Education* 91(1) (2002): 33-39.
18. Kuratko, D. F., "The emergence of entrepreneurship education: development, trends, and challenges", *Entrepreneurship Theory and Practice* 29(5) (2005): 577-597.
19. Cockx, R., De Vocht, S., Heylen, J., and Van Bockstaele, T., "Encouraging Entrepreneurship in Europe: A Comparative Study Focused on Education", Antwerpen: UFSIA (University of Antwerpen, 2000).
20. Streeter, D., Jaquette, J., and Hovis, K., "University - wide entrepreneurship education: Alternative models and current trends" (Working Paper 2002-02, Department of Applied Economics and Management, Cornell University, 2002).
21. Brand, M., Wakkee, I., and van der Veen, M., "Teaching entrepreneurship to non-business students: insights from two Dutch universities" in *Handbook of Research in Entrepreneurship Education, vol. 2, Contextual perspectives*, ed. Fayolle, A., (Edward Elgar Pub., 2007): 52-83.
22. Birch C.J., and Clements M., "Can do, want to do and am going to do! Changing an anti-entrepreneurial culture to enable sustainable economic regeneration", (Working paper, Starfforshire University, Jacksonville, 2004).
23. Anderson, A. and Jack, S., "Role typologies for enterprising education: the professional artisan?", *Journal of Small Business and Enterprise Development* 15(2) (2008): 259-273.
24. Laukkannen, M., "Exploring alternative approaches in high-level entrepreneurship education: Creating micromechanisms for endogenous regional growth", *Entrepreneurship and Regional Development* 12 (2000): 25-47.
25. Heinonen, J., and Poikkijoki, S.-A., "An entrepreneurial directed approach to entrepreneurship education: Mission impossible?", *Journal of Management Development* 25(1) (2006): 80-92.
26. Fiet, J., "The theoretical side of teaching entrepreneurship", *Journal of Business Venturing* 16 (2000): 1-24.
27. Taatila, V. P., "Learning entrepreneurship in higher education", *Education and Training* 52(1) (2010): 48-61.



28. Huovinen, J., and Tihula, S., "Entrepreneurial learning in the context of portfolio entrepreneurship", *International Journal of Entrepreneurial Behaviour & Research* 14(3) (2008): 152-71.
29. Dolabela, F., "The Entrepreneurial Pedagogy Methodology", World Entrepreneurship Forum, accessed April 2012, <http://www.world-entrepreneurship-forum.com/Do-Tank/Members-Initiatives/The-Entrepreneurial-Pedagogy-Methodology>
30. Ajzen, I., "The theory of planned behavior", *Organizational Behavior and Human Decision Processes*, 50 (1991): 179-211.
31. Souitaris, V., Zerbinati, S., and Al-Laham, A., "Do entrepreneurship programmes raise entrepreneurial intention of science and engineering students? The effect of learning, inspiration and resources", *Journal of Business Venturing*, 22 (2007): 566-591.
32. Henry, C., Hill, F., and Leitch, C., "Entrepreneurship education and training: can entrepreneurship be taught? Part II", *Education and Training*, 47(3) (2005): 158-169.
33. Matlay, H., "The impact of entrepreneurship education on entrepreneurial outcomes", *Journal of Small Business and Enterprise Development*, 15(2) (2008): 382-396.
34. Henry, C., Hill, F. and Leitch, C., "Entrepreneurship Education and Training", Ashgate, Aldershot, 2003.
35. Storey, D.J., "Six steps to heaven: evaluating the impact of public policies to support small business in developed economies", in *The Blackwell Handbook of Entrepreneurship*, ed. Sexton, D., and Landstrom, H., (Blackwell, Oxford, 2000): 176-193.
36. McMullan, E., Chrisman, J.J. and Vesper, K., "Some problems in using subjective measures of effectiveness to evaluate entrepreneurial assistance programs", *Entrepreneurship Theory and Practice* 26(1) (2001): 37-54.
37. Charney, A. and Libecap, G., "The impact of entrepreneurship education: an evaluation of the Berger Entrepreneurship Program at the University of Arizona, 1985-1999", *May report to The Kauffman Centre for Entrepreneurial Leadership*, Kansas City, MO, (2000).
38. Lee, S.M., Lim, S.-B., Pathak, R.D., Chang, D., and Li, W., "Influences on students' attitudes towards entrepreneurship: a multi-country study", *International Entrepreneurship and Management Journal*, 2(3) (2006): 351-366.
39. Veciana, J., Aponte, M. and Urbano, D., "University students' attitudes towards entrepreneurship: a two country comparison", *International Entrepreneurship and Management Journal*, 1(2) (2005): 165-182.
40. van der Akker, J., Gravemeijer, K., McKenney, S., & Nieveen, N., "Educational design research", 2006, London: Routledge.
41. Bergevoet, R.H.M., and Woerkum, C. V., "Improving the Entrepreneurial Competencies of Dutch Dairy Farmers through the Use of Study Groups", *The Journal of Agricultural Education and Extension*, 12(1) (2006): 25-39.
42. King, C., Gaffiely, J., and Gunton, J., "Does participatory action learning make a difference? Perspectives of effective learning tools and indicators from the conservation cropping group in north Queensland, Australia", *The Journal of Agricultural Education and Extension*, 7(4) (2001): 133-146.
43. Bermejo, L. A., Lobillo, J., and Molina, C., "Aportes del DRP (Diagnóstico Rural Participativo) a las metodologías participativas y aplicación a la gestión de los recursos naturales en la Gomera", *Curso de Metodologías participativas para el desarrollo local*, Universidad Complutense de Madrid, Madrid, España, 2004.
44. Herrington, J., and Reeves, T.C., "Using design principles to improve pedagogical practice and promote student engagement", in *Changing demands, changing directions*, Wrest Point, Hobart Tasmania, Australia, Ascilite 4-7 December 2011.
45. Pittaway L., "Institutional strategies for developing enterprise education: a review of some concepts and models", 2007, <http://www.york.ac.uk/enterprise/cetle/docs/papers/>.
46. Nab, J., Pilot, A., Brinkkemper, S., Ten Berge, H., "Authentic competence-based learning in university education in entrepreneurship", *International Journal of Entrepreneurship and Small Business* 9(1) (2010): 20-35.
47. Gibb, A., "Creating the entrepreneurial university: do we need a wholly different model of entrepreneurship?" in *Handbook of Research in Entrepreneurship Education, vol. 1, A General Perspective*, ed. Fayolle, A., (Edward Elgar Pub., Cheltenham, UK, Northampton, MA, USA, 2007): 67-103.
48. Pajarinen, M., Rouvinen, P. and Ylä-Anttila, P., Uusyrityjen kasvuhakuisuus, KTM julkaisu, (Ministry of Employment and the Economy, Helsinki, 29/2006).



49. Sambataro, M. (2000), "Just in time learning", *Computerworld*, accessed June 2012 [http://www.computerworld.com/s/article/44312/Just\\_in\\_Time\\_Learning](http://www.computerworld.com/s/article/44312/Just_in_Time_Learning).
50. Bulte, A.M.W., Westbroek, H.B., De Jong, O., & Pilot, A., "A research approach to designing chemistry education using authentic practices as contexts", *International Journal of Science Education* 28(9) (2006): 1063-1086.
51. Honig, B., "Entrepreneurship education: toward a model of contingency-based business planning", *Academy of Management Learning and Education* 3(3) (2004): 258-273.
52. Gibb, A.A., "Entrepreneurship and small business management: can we afford to neglect them in the twenty-first century business school?", *British Journal of Management* 7 (1996): 309-321.
53. Gibb, A.A., "Small Firms training and competitiveness. Building upon the small business as a learning organisation", *International Small Business Journal* 15(3) (1997): 13-29.
54. Hayward, G., "Evaluating Entrepreneurship in Scottish Universities" (Oxford: University of Oxford Education Department, 2000).
55. Gibb, A. A., "Entrepreneurial core capacities, competitiveness and management development in the 21<sup>st</sup> century", *IntEnt Conference*, Oestrich-Winkel, (1998).
56. Hytti, U., Stenholm P., Heinonen, J., and Seikkula-Leino J., "Perceived learning outcomes in entrepreneurship education. The impact of student motivation and team behaviour", *Education and Training* 52(8/9) (2010): 587-606.
57. York, A.S., McCarthy, K.A. and Darnold, T.C., "Building biotechnology teams: personality does matter", *Journal of Commercial Biotechnology* 15(4) (2009): 335-46.
58. Innes, R.B., "What can learning science contribute to our understanding of the effectiveness of problem-based learning groups?", *Journal of Management Education* 30(6) (2006): 751-64.
59. Swiss Federal Institute of Technology. Chair of Entrepreneurship. Tutorship, accessed August 2012, <http://www.entrepreneurship.ethz.ch/education/Tutorship>
60. Bozeman, B., and Feeney, M. K., "Toward a useful theory of mentoring: A conceptual analysis and critique". *Administration & Society* 39(6) (2007):719-739.
61. Spanish center of sociological research (CIS), Barometer June 2006, accessed May 2011, [http://www.cis.es/cis/opencv/ES/1\\_encuestas/estudios/ver.jsp?estudio=5717](http://www.cis.es/cis/opencv/ES/1_encuestas/estudios/ver.jsp?estudio=5717)
62. Pruett, M., Shinnar, R. S., Toney, B., Llopis, F., and Fox, J., "Explaining entrepreneurial intentions of university students: a cross-cultural study", *International Journal of Entrepreneurial Behaviour and Research* 15(6) (2009): 571-594.

### AUTHORS



**Leovigilda Ortiz-Medina** is Ph.D. candidate attached to the Unit of Production Systems Engineering, in the Higher School of Agricultural and Forestry Engineering of the University of Cordoba. Since 2002 she has worked at the University of Córdoba in the management of post-graduate programs and in projects for the improvement of teaching quality, especially in the field of employment and business creation. Since 2011, she is also involved in the European Program ALFA-III, Agroempresas-project, with European and Latin American universities for promotion of Entrepreneurship in Agro-food studies.



**Elvira Fernández-Ahumada**, is an Agro-food Campus of International Excellence Postdoctoral Fellow in the Biosystems Engineering Research group of the University of Cordoba (UCO). In addition to her research she is involved in the promotion of entrepreneurship for agricultural and forestry engineering students and in the European Program ALFA-III, Agroemprendes-project. She received her Ph.D. in Agricultural Engineering from UCO, and also trained at Iowa State University and University College London. She had postdoctoral positions at the National Research Institute of Science and Technology for Environment and Agriculture in Montpellier (France) and the International Center for Agricultural Research and Development, also in Montpellier. Corresponding author: [g82feahe@uco.es](mailto:g82feahe@uco.es)



**Pablo Lara Vélez** is full professor in the Production Systems Engineering Group, Higher School of Agricultural Engineering and Forestry, University of Córdoba. He has been a member of the team for promotion of entrepreneurship in agricultural and forestry engineering students from its inception, as well as partner in the Entrepreneurship Program in the School of Industrial Organisation (EOI). Since 2011, he has been part of the European Program ALFA-III, Agroemprendes-project. His research focuses on economics applied to animal production.



**Ana Garrido-Varo** has a Ph.D. in Agricultural Engineering (University of Córdoba). She is Professor in Fundamentals and Technology of Livestock Production and in Non-destructive Spectral Sensors for Quality, Safety and Traceability of Agro-Food Products. She has over twenty years' experience in the field of Near Infrared Spectroscopy (NIRS), and leads the Non-Destructive Spectral Sensors Unit (NDSSU) at her School. She previously was Head of NIRS activities at the Centralized NIRS-Sample Bank Unit of the University of Córdoba. She has chaired the Education Group of the International Council for Near Infrared Spectroscopy (ICNIRS) since 2007. She is also a member of the Editorial Advisory Board of the Journal of Near Infrared Spectroscopy.



**Dolores Pérez-Marín** serves Senior Lecturer in *Fundamentals and Technology of Livestock Production* and in *Non-destructive Spectral Sensors for Quality, Safety and Traceability of Agro-Food Products* in the Higher School of Agricultural and Forestry Engineering (ETSIAM, UCO). In addition, she is Director of the Master *Agro-Food Plants Projects and Management* and Academic Secretary in her College. Her main research expertise is related



## Assessing an Entrepreneurship Education Project in Engineering Studies by Means of Participatory Techniques

to NIR Spectroscopy and multivariate analysis, working on an ever widening range of applications in food and agriculture .. feed, fats and oils, meats, protein animal by-products, milk and dairy, and various fruits and vegetables.



**José Emilio Guerrero-Ginel** is Full Professor in the Higher School of Agricultural Engineering and Forestry (ETSIAM) at the University of Córdoba. He currently coordinates the team for promotion of entrepreneurship in agricultural and forestry engineering students. He is also coordinator of the Doctoral Program “Sciences and Technologies in Agricultural, Food, Natural Resources and Rural Development.” He is professor of several courses of initial and continuing training in Spain, Europe and Latin America on animal production, environment and rural development, and author of over 150 publications on topics related to animal production, environment and regional development.