COMPETENCE ASSESSMENT IN HIGHER EDUCATION: A DYNAMIC APPROACH

F. Achcaoucaou[1], L. Guitart-Tarrés[1], P. Miravitlles-Matamoros[1], A. Núñez-Carballosa[1], M. Bernardo[1], A. Bikfalvi[2]

[1]Universitat de Barcelona (SPAIN)
[2]Universitat de Girona (SPAIN)

farizaa@ub.edu, laura.guitart@ub.edu, paloma.miravitlles@ub.edu, ana.nunez@ub.edu, merce.bernardo@ub.edu, andrea.bikfalvi@udg.edu

Abstract

Advances in the implementation of European Higher Education Area (EHEA) have had a great impact on university environment and the process of design, evaluation and implementation of new curricula. Identifying competence levels among students can help course organizers to improve both the academic content and the teaching/learning processes. The present study addresses this issue by examining the implementation of an Internet-base competency assessment tool. We analyze the status and evolution of soft skills among students on the Official Masters programme *Creating and Managing Innovative Technology-Based Companies* at the University of Barcelona, using a tool known as Tricuspoid, specifically designed for evaluating entrepreneurial competences. The results show that the tool, first, enables students to identify their strong and weak points and to develop personal strategies for improvement; second, provides teachers with additional information about the effects of their input on student competences; and third, supplies useful information for quality management of the Masters programmes, since it can detect trends in the training needs of new students and help to enhance content accordingly, and therefore, match the design of the academic programme to the requirements of labour market.

Keywords: competence assessment, competence development, higher education, ICT, quality

1. INTRODUCTION

Universities, as important and powerful players in any innovations system –both regional and national- each time more tend to assume entrepreneurial behaviour. In this context, these knowledge intensive service-based institutions rely on innovation and quality as competitiveness factors.

The construction of the European Higher Education Area (EHEA) has brought with it several profound changes in the university environment and the process of design, evaluation and implementation of new curricula. The reshaping of degree courses, the introduction of a new credit accounting system focused on student workload (the European Credit Transfer System - ECTS) and methodologies for competence learning, are three central features of this new educational paradigm.

In fact, Spanish universities have been very careful in defining the competences that students must achieve through new degree and postgraduate courses. However, they have paid less attention to the question of how these competences should be measured.

In many cases, student skills cannot be evaluated by the traditional assessment methods used in education today (Makatsoris, 2009). A recent analysis of several degree syllabuses in Spain highlighted the deficiencies of these traditional methods (Mano-González and Moro-Cabero, 2010). In general, the process of competence assessment has been somewhat neglected in Spanish higher education.

Moreover, there are only ten Spanish universities in the Academic Ranking of the top 500 World Universities, and the highest is at number 200 (see Table 1). There are three corollaries of this fact. First, Spanish universities are far from leading the world's

top universities. Second, and as a consequence of this, there is still a great deal of improvement to be achieved in terms of academic and research performance. Third, and more optimistically, there are Spanish universities that achieve a high ranking, and one of them, the University of Barcelona (UB) is the site for the present research study.

(Insert Table 1 here)

Improving teaching and research quality should be a priority of any higher education institution. The present study addresses the issue of teaching by exploring the implementation of a tool for competence assessment. Evaluating knowledge, group profiles and shared development needs can contribute to the design of more responsive and individualised teaching and learning solutions. Students might feel more involved and this may impact their perceptions of quality in their studies.

One generic document, the Official Journal of the European Union[1] (2010), identifies and defines eight key competences necessary for personal fulfilment, active citizenship, social inclusion and employability in a knowledge society. These are: (1) communication in one's mother tongue, (2) communication in foreign languages, (3) mathematical competence and basic competence in science and technology, (4) digital competence, (5) learning to learn, (6) social and civic competence, (7) sense of initiative and entrepreneurship, and (8) cultural awareness and expression. Leaving aside the scope and accuracy of these definitions, and their use in competence-based education, we merely highlight the fact the present study focuses on one of the key competence areas defined by the European Union, namely entrepreneurship.

Entrepreneurship is a key element both from a competence/training perspective and from a more strategic/employment vision. Nowadays, in complex socioeconomic

[1] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2010:117:0001:0007:EN:PDF

situations, self-employment and creating one's own business are possible job seeking solutions both for young graduates and for the unemployed. Therefore, increasing awareness of the importance of competences and training for entrepreneurship are key issues in the present field of higher education.

This paper describes our experience of applying the digital platform *Evolute* developed by Tampere University of Technology in Finland (Kantola, 2009; Kantola, 2005; Kantola et al. 2005; Vanharanta, 2005). This is an ICT-based digital platform designed for the self-assessment of personal and social competences, and it uses different models of competences for a range of specific work role profiles. Each competence model is based on a specific ontology according to the target domain (Paajanen et al., 2009). In particular we apply an evaluation tool called Tricuspoid, which was specifically designed for self-evaluating entrepreneurial competences (Palonen, 2005). The main reason for using it is that it fits the syllabus and the broad competence goals defined for the masters degree under consideration, namely the *Creation and Management of New Technology-Based Firms,* at the University of Barcelona, Spain.

Although similar studies using the same exact tool in this context are non-existent, there are other publications describing the use of other Evolute platform tools in similar settings. This is the case of Tampere University of Technology at Pori in Finland (Kantola et al., 2005), in the Brunel University West London in the UK (Makatsoris, 2009), with engineering students in South Korea (Chang et al., 2007), with university students in South Korea and Finland at three different universities (Chang et al., 2009) and the case of the University of Girona in Spain (Bikfalvi et al., 2007).

This ICT-based tool enables an individual to self-assess the own competencies and obtain immediate feedback about their competences. Participants have to assess their current and target perception for a set of statements related to the entrepreneurs' every

day situations. Then, this allows to combine and sum the abstract, subjective perceptions of individuals, resulting in aggregate indicators measuring the competence ontology of a person. Therefore, individuals do not directly evaluate their performance and this avoids the usual bias induced by the assessment of the own work-related performance. In addition, considering both the current awareness and future goal in competences, it allows to identify where there is a perceived need for learning, namely creative tension (Senge, 1994). Based on the mentioned statements and supported by the ontology, the tool generates instantaneous competence reports. The point is to use these reports for planning personal strategies for development, as well as, for detecting target training and development for individuals and groups by organizations. In this case, the analysis was carried out during the academic year 2009/2010, shortly after the programme was established, the aim being to assess the extent to which the course content matched the needs of society and, where necessary, to make any improvements required.

Being able to match training with the needs of the labour market is important not only for those who are charged with designing academic programmes in different fields, but also for educators who wish to become more efficient in their teaching activity. In order to achieve such a match it is necessary to determine the initial level of a student's competence at the start of a given academic programme, compare this with what is required by the career they seek to enter, and tailor the teaching/learning process accordingly. However, these skills and competences are not readily captured through traditional assessment methods (Makatsoris, 2009), and their analysis becomes even more difficult in the context of new postgraduate courses, due to the wide range of backgrounds from which students come. In this context the use of Internet-based applications provides a cost-effective and quick way of assessing the competences of individual students and of monitoring them throughout the course.

The overall aim of the study reported in this paper is to increase our understanding of ways of assessing competences and illustrate how these can benefit the university community. More specifically, the focus is on improving the work of teachers and the learning achieved by students, but also to support the strategic management of higher education institutions. The three broad objectives are as follows:

1. To validate instruments for data collection and methods of analysis that can help teaching staff to analyse and evaluate the acquisition and mastery of competences by students.
2. To examine the utility of self-assessment of competences and the use of an ICT-based tool for providing feedback on student progress.
3. To determine the extent to which the tool *Tricuspoid* provides useful information for the quality management of a masters programme.

New information on the results attained by student learning provides vital material for debate in the institution's efforts towards continuous improvement. Identifying and analyzing the educational needs of students and determining their fit with the demands of society at large contributes to the improvement of educational policy at the masters level with respect to the teaching staff, curriculum designers and the university itself when planning future courses.

The paper is structured as follows. After the introduction, we review the theoretical framework of competences and we introduce the competence model of the entrepreneurship profile. Then, the third section provides an overview of the masters programme *Creation and Management of New Technology-Based Firms*. The next section contains a description of the methodology. Finally, the fifth and sixth sections offer the results and conclusions of this research, respectively.

2. THEORETICAL FRAMEWORK

2.1. The literature on competences

The term “competence” has taken on great importance within the current educational paradigm, although there seems to be no consensus over its definition. This is perhaps unsurprising given the wide range of fields involved and the diversity of approaches used in the study of competences (Sultana, 2009). Nevertheless, notable efforts have been made to describe and clarify the different approaches to the concept, good examples being the work of Winterton et al. (2005), Delamare Le Deist and Winterton (2005), and Mulder et al. (2007). These and other studies point out that a distinction has traditionally been made between three main approaches: the behavioural, the functional and the holistic.

The behavioural approach, as proposed by McClelland (1998), is based on the evaluation of demonstrable and observable behaviour. Authors who adopt this perspective consider competences to be those attributes of a person which are related to the effective execution of a task, and to performance that is notably better than that of other individuals carrying out the same activity (Delamare Le Deist and Winterton, 2005; Spencer and Spencer, 1993; White, 1959). Consequently, it is an approach that focuses on those personal attributes which are readily applicable to other work contexts.

The functional approach is given particular emphasis in the United Kingdom, due to the government’s efforts to implement a nationally-coordinated competence-based system of training in the workplace. In the functional approach, competence refers to those attributes that enable a set of tasks to be successfully carried out (functions that are more or less permanent). These functions take precedence over the personal attributes

of the individual who performs the task (Blanco-Prieto, 2007). Therefore, this approach centres on work outcomes, in accordance with a number of parameters that have previously been established in relation to a specific activity.

The holistic approach seeks to integrate the above two perspectives. Thus, it considers competences to be those attributes required to perform a task in accordance with a set of specified parameters. In sum, it links the analysis of individual attributes (the behavioural approach) with the study of the characteristics needed in a given workplace (the functional approach). This approach is traditionally associated with the system of training used in France and Germany.

The holistic approach provides the conceptual framework of competence adopted in the present study, drawing upon the definition of Bikfalvi et al. (2007), who state that, "Competences refer to the attributes, knowledge, skills, experience and values that an individual needs to carry out his/her tasks". This definition links the general attribute approach with the context in which such attributes are put into practice.

2.2. Specific competences and generic competences

The literature contains descriptions of multiple typologies of competences. At times, the classifications can be contentious, making use of different words to name the same groups of competences or naming conceptually distinct competences in the same way.

Although there is no single classification, a large number of authors (Bunk, 1994; Mertens, 1996; Lévy-Leboyer, 1997; Pereda and Berrocal, 2001; Becker, et al., 2002; Heijke et al., 2003; Ennis, 2008; de Miguel et al., 2006) and reports such as Tuning Educational Structures in Europe II (2005), also known as Tuning II, are in broad

agreement in distinguishing between generic and specific competences, albeit with differing degrees of explicitness.

Within this theoretical framework, specific competences are related to the area or areas of knowledge and professional practice specific to a degree, while generic competences, which are also known as cross-disciplinary or transferable competences, refer to the qualities needed by students in their role within society as professionals and citizens. In this respect, the European Higher Education Area (EHEA) has underscored the importance of mastering generic competences during university education (Hernanz et al. 2004). However, until very recently, subject-area related competences have been the central focus and little attention has been given to cross-disciplinary competences, possibly because they are difficult to develop through education and their measurement and assessment pose greater challenges (Baños and Pérez, 2005).

The experience presented here, addressing the two limitations noted above, proposes and validates an analysis and assessment tool centred on the acquisition and mastery of generic competences.

2.3. Competence development

In the previous section, competences are defined as the characteristics, knowledge, skills, experience and values that an individual needs to perform successfully in an academic or professional context. Two types of competences are defined: specific and generic. However, competences are not static; they evolve over time.

Students' growth in competences will be affected by the educational and workplace context in which they are immersed (Massot and Feisthammel, 2003). That is, in order

for their academic and professional experience to be really productive, the level of competences attained by the end of an educational programme or professional training should be substantially higher than the level of competences possessed beforehand. By analyzing whether teaching/learning processes within a specific academic programme aid the development of the competences required for practice in a profession, we will obtain information vital for managing the quality and continuous improvement of the programme and provide empirical evidence of the contribution of the degree to society at large.

Managing competences often results in a difficult and challenging task, especially in knowledge and learning environments. According to Kantola (2005; 2009), increasing the number of correct managerial decisions is possible by systematically constructing organizational resources as ontologies. As described in Jonassen (2006) and Kantola et al. (2011) ontologies define the common words and concepts (meanings) that describe and represent an area of knowledge. Using ontologies can have several benefits, such as interoperability, browsing and searching, reuse and structuring of knowledge. They also enable the computational processing of information.

Another important facet of competence assessment and development is its dynamism. Especially for educational purposes, it is important to know an individual's vision for the future. Senge (1994) has called this future visioning the "creative tension". According to Senge, in order to achieve a high level of personal mastery, people must share several basic characteristics: "They have a special sense of purpose that lies behind their vision, they share the 'current reality' as an ally not an enemy, they are deeply inquisitive, i.e. committed to continually seeing reality more and more accurately, they feel connected to others and life itself, they feel as if they are part of a larger creative process and live in a continually learning mode" (Senge, 1994: p. 142) It is a tension/gap between the visioning of the future and the idea of current reality.

For this reason, in the case of the experience presented here, the research not only assesses generic competences relative to students' entrepreneurial profile, but also analyses their evolution.

This approach is consistent with the emerging "co-evolutionary management paradigm" introduced by Vanharanta (2005) and Vanharanta et al. (2005) as a way to shift the focus of analysis to the need for fundamental understanding of the natural processes of continuous co-evolving of individuals and the organizations.

In the higher education context, students must think themselves of the future and understand what might be doing by developing their resources and removing constraints, although still operating within the bounds of what is already known to be feasible, that is "potentiality". If this potentiality is carried out even further, according to Vanharanta et al. (2005), the personal level of the future state a student is targeting towards should be found out, i.e., the individual's creative tension. On the current level, it is important to know what a person manages to do now, i.e., how she/he performs at the present and what are the constraints of such performance? The capability to do something is the best ability or quality that the student could exhibit now. The human competence, in turn, is the ability of doing something well and effectively in the immediate future (expanding on the potentiality), i.e., capability for active use. This also gives reasoning to the importance of time in the overall equation and, in our specific, trainning framework, teachers' intended intervention.

2.4. Models of competences

A model of competences is a descriptive tool that serves to identify the skills, knowledge and personal attributes required to achieve effectively a set of objectives,

whether in terms of student learning or workers' ability to fulfil their role within an organization, i.e. occupational role . In other words, it is a description of the competences needed to function in a specific job or workplace (Ennis, 2008; Gangani et al., 2006; Lucia and Lepsinguer, 1999) and serves to evaluate individual competences in relation to a given profile (Zwell, 2000). These competences are often presented in the form of a hierarchy and categorized with maps (Sandwith, 1993).

In the present study the assessment of competences in relation to entrepreneurial profiles was based on the tool known as *Tricuspoid – Entrepreneurs' competences*, which is described in detail by Palonen (2005). This model is shown in Figure 1.

(Insert Figure 1 here)

3. THE MASTERS DEGREE *CREATION AND MANAGEMENT OF NEW TECHNOLOGY-BASED FIRMS*

The idea of a masters degree in *Creation and Management of New Technology-Based Firms* was put to the Catalan government (Generalitat de Catalunya) by the Faculty of Economics and Business of the University of Barcelona, with a proposed start date of the academic year 2008/2009. The aim was to develop a reference platform capable of providing high-level training, skills and qualifications for entrepreneurs in technology-based companies and, in general, for the managers of innovative firms.

The masters degree is designed so that students acquire the competences required to achieve the following objectives satisfactorily: (a) To carry out processes related to the creation of companies, especially those which are technology-based, (b) To manage technology-based companies from start-up through consolidation, (c) To design and successfully implement R+D+I projects and management plans within the company,

and (d) To have in-depth knowledge of the scientific and technological context, and of the key players within it, in order to develop cooperation and technology-transfer agreements with them. The aim is thus to equip students with the competences required to implement new enterprise initiatives and establish, with a strong likelihood of success, a wide range of innovative projects.

In addition to the specific competences of each subject, the masters programme also carefully organizes educational activities explicitly aimed at developing mastery of the generic competences. A summary of these activities and their purposes is presented in Table 2.

(Insert Table 2 here)

Given the characteristics of this masters degree and the importance of entrepreneurship in this context, we believed it would be interesting to explore how the tool *Tricuspoid – Entrepreneurs' competences* could be used to measure student learning outcomes.

4. METHODOLOGY

The deployment of the tool has been adapted from Bikfalvi et al. (2007) and Makatsoris (2009) for similar projects. Thus, the application of the tool can be broken down into a series of steps (see Figure 2) covering three stages: pre-evaluation (Steps 1 to 7), evaluation (Step 8) and post-evaluation (Steps 9 and 10).

(Insert Figure 2 here)

In the pre-evaluation stage, students are provided with information and documentation about the objectives, content and functioning of the tool. They are also given all the necessary instructions to ensure they can use the tool successfully, together with the username and password required to access the system.

The evaluation stage of the tool is based on the indirect self-assessment of broad competences. Thus, students are asked to respond to a series of statements related to their daily work, but these are phrased in such a way that their impression is that they are assessing their attitudes, perceptions and feelings, rather than their performance. For each statement they are asked to identify their current level of competence and indicate the level they would like to achieve. Statements are graded using a fuzzy scale, with labels such as always, often, sometimes or never. The difference between the two levels (current and desired) is referred to as the creative tension, on the basis of which it is possible to identify competences for which the student perceives the need to learn. In other words, one can identify those areas on which further training could usefully be focused.

Students carry out a self-assessment on their competence levels at the start of the educational programme (in October), and they repeat the self-assessment after completing their final masters project (in July or September). The comparison of the two self-assessments offers a view of the evolution of their competences during the programme.

The evaluation contains 132 items relating to daily work activities. The scores derived from the responses given, for both the current and desired levels, provide an immediate evaluation of 33 broad competences (personal and social) as shown in Figure 1.

After completing the self-evaluation, participants are given a post-evaluation questionnaire in order to gather information about how they perceived various aspects such as the importance of the competences assessed, the subjective validity of the tool, and their opinion about the extent to which their studies have helped them to develop their competences.

5. RESULTS

5.1. Student profile

In the academic year 2009/2010 a total of twenty-five students were enrolled in the masters programme, *Creation and Management of New Technology-Based Firms*. Of those twenty-five students, twenty were studying full-time and submitted their final project between July and September 2010. A total of eighteen students completed the self-assessment of competences using Tricuspoid, which gives a participation rate of 90%. Table 3 shows the profile of students who participated voluntarily in the project.

(Insert Table 3 here)

5.2. Results of competence assessment using the tool

An individual's competences are not static. They change and can be shaped by appropriate activities designed to develop responses that best fit the individual's academic or workplace context.

Creative tension refers to the aspects of an individual that he or she perceives as weaknesses or strengths[2], and therefore points to areas offering greater or smaller opportunities for development with respect to hypothetical future professional roles. It follows that a quality educational programme should contribute to diminishing creative tension as the individual progresses the teaching programme.

This section offers an analysis of the effect of teaching/learning processes within the Master in Creation and Management of New Technology-Based Firms on the level of student competences, especially with respect to creative tension. With this aim in mind, students undertook a self-assessment twice during the academic year 2009/2010. The aim was to gather evidence of the extent to which the masters programme had the desired effect, both overall and with respect to the activities explicitly designed to develop student mastery of generic competences. The variations in students' levels of competence and the analysis of variance (ANOVA) for the 33 competences in the model are presented in Table 4. Table 5 shows the competences clustered into six groups, while Table 6 clusters the competences into two main groups, namely social and personal competences. Figure 1 provides a mapping of the clusters of competences.

(Insert Table 4 here)

(Insert Table 5 here)

(Insert Table 6 here)

[2] Competences with a higher creative tension are those where there is a greater gap between the current and the desired levels. They are the competences for which the students perceive a themselves to be relatively weaker, and therefore have a greater need for improvement. In contrast with this, the competences with a lower creative tension, are those where students' current level of competence is similar to or higher than their desired level, and where they feel they are better prepared. Areas of low creative tension are therefore viewed as strengths.

In general terms, Table 4 shows that the variation in creative tension for 30 of the 33 competences is negative, which is to say that in the majority of areas creative tension has diminished. The competences with the sharpest fall in creative tension and statically significant are, in order: Production efficiency, Metacognitive skills, Decision-making skills, Analytical thinking, and Innovativeness. In these cases, the fall is greater than 10 points on a 100-point fuzzy scale. (Here, and in the discussion that follows, all references to scores refer to this scale). In other words, students perceive that their improvement in these competences has risen by a minimum of 12.31 points over the academic year. In contrast with those areas, students see a decline in the competences Conceptual thinking, Self-capacity (capability) and Flow. For these three competences, creative tension has risen by 0.42, 2.58 and 8.39 points respectively. This finding, although it is not statically significant, indicates a need to readjust the educational activities to strengthen these competences in students.

Turning to the six clusters of competences in Table 5, the cluster marked by the greatest improvement is Self-control (with a fall in creative tension of 8.20 points), followed closely by Cognitive capacity (with a fall of 7.47 points); both with statistical significance at 95%. On the other hand, the clusters Self-knowledge and Motivating oneself register a much lower decline in creative tension (2.87 and 2.66 points, respectively).

The variation in creative tension for the two main groups of competences, Social Competences and Personal Competences, is very similar although the latter is the only one statistically significant, as shown in Table 6. Social competences (5.77 points) fall slightly more than personal competences (5.62 points), but the fact that analysis at this level shows very little difference highlights the value of conducting the analysis at higher levels of disaggregation.

5.3. Validation of the tool as an instrument for the self-assessment of competences

This section describes students' perceptions regarding the importance of the competences assessed, the validity of the tool for evaluating these competences, and their opinions about the extent to which their studies have helped them to develop their competence in relation to entrepreneurship. Table 7 shows the corresponding results as measured on a seven-point Likert scale, where 1 means "None" and 7 means "Very much".

Firstly, it can be seen that students ascribe considerable importance to the social and personal competences described in the model, with the scores assigned being over 5.5 out of 7. Secondly, the results obtained from the evaluation of each of the six competence groups illustrate that students regard the tool as an appropriate and valid measure of their competences, with scores of 3.7 out of 7, or higher. Finally, the students believe that the masters programme makes a substantial contribution to the development of their broad competences. The competence which they regarded as being most developed was Motivating oneself (score of 5.94), and even the competence which they felt was least influenced by their studies, namely Cognitive capability, still achieved a high score (5.44).

(Insert Table 7 here)

These results, together with the others obtained during the project described in this paper, provide valuable information that can be used to develop strategies for improving the quality of the University of Barcelona's masters programme in the *Creation and Management of New Technology-Based Firms*.

Overall, assessment of professional competence and development in the business field shows that the success of any competence-based development is highly dependent on the participant's motivation to use such a technique to attain personal mastery. This is likely to be the case in educational environments that are designed to stimulate the development of competence. We believe that two ingredients for the success of competence based education are the motivation of students to participate and to believe in its benefits, on the one hand, and the motivation of, and specific training for, the teaching staff on competence assessment and development, on the other hand.

6. CONCLUSIONS

Identifying competence levels among new students can help course organizers to improve both the academic content and the processes of teaching and learning. In this regard, it is necessary to ensure that the content of training is tailored, not only to the needs of students, but also to what is required by society in terms of newly qualified professionals. Similarly, evaluating the effect that training has on the level and evolution of students' competences is an excellent quality indicator in any teaching context. Therefore, the availability of a suitable and valid method of measuring these competences, before, during and after training, takes on strategic importance.

The project described in this paper recognizes this need and proposes using the digital platform *Evolute* to assess broad competences. The implications of the research results fall in two broad areas, empirical and methodological. In relation to the methodological implications, three main conclusions can be drawn from the results obtained: (1) At the level of teaching, the tool provides teachers with additional information about the effect of their input on students' competences, doing so at a negligible cost (in terms of time and effort), and it complements other assessment

instruments or methods that teachers might use to evaluate the outcomes of competence-based teaching/learning; (2) At the individual level the tool should be considered as a support for each student's personal development, since it enables him or her to identify strong and weak points and to develop personal strategies for improvement that can have an impact on his or her entrepreneurial profile and academic performance; (3) At the institutional level the tool provides an opportunity for continuous improvement, since it can detect trends in the training needs of new students and help tailor the academic programme to the competences that have to be developed. This last aspect is important in the context of masters degrees, where close links with professional careers mean that particular attention is paid to quality, not only by universities and certification and accreditation agencies, but also by various key players in the business community. Among other things this has led to an increasing emphasis being placed on the competences required for the professional career toward which the training and qualifications are geared.

In relation to the empirical implications, the results obtained by applying the tool in the Master in Creation and Management of New Technology-Based Firms shows that, in general terms, the creative tension of different competences in the model diminishes after a period of education, and we interpret that as indicating that the masters programme has a positive effect by contributing to the students' current competence levels moving towards their desired levels. More specifically, activities explicitly aimed at developing mastery of generic competences (e.g. case studies, specialized seminars, outside visits and the final masters project) had the desired effect on these competences. Moreover, according to the co-evolving management paradigm we now have evidence that education, learning, understanding the own level of competences is very important and also that teachers' intended interventions help students to improve individual specific competences. Even so, more evidence would be valuable in extending these conclusions, and we aim to increase the number of participants in

future research. Furthermore this would permit the use more advanced statistical techniques in order to establish a cause-effect relationship between studies and achieved levels of competences.

We believe that the initial findings of the research are of interest to the managers and heads of educational institutions, as well as to national accreditation and assessment agencies. Although this was a pilot project, the results produced are clear and it is hoped that further work can now be conducted along similar lines. One such future line of work would be to apply this methodology to the assessment of competences within the framework of the new degree courses being offered by the Faculty of Economics and Business of the University of Barcelona.

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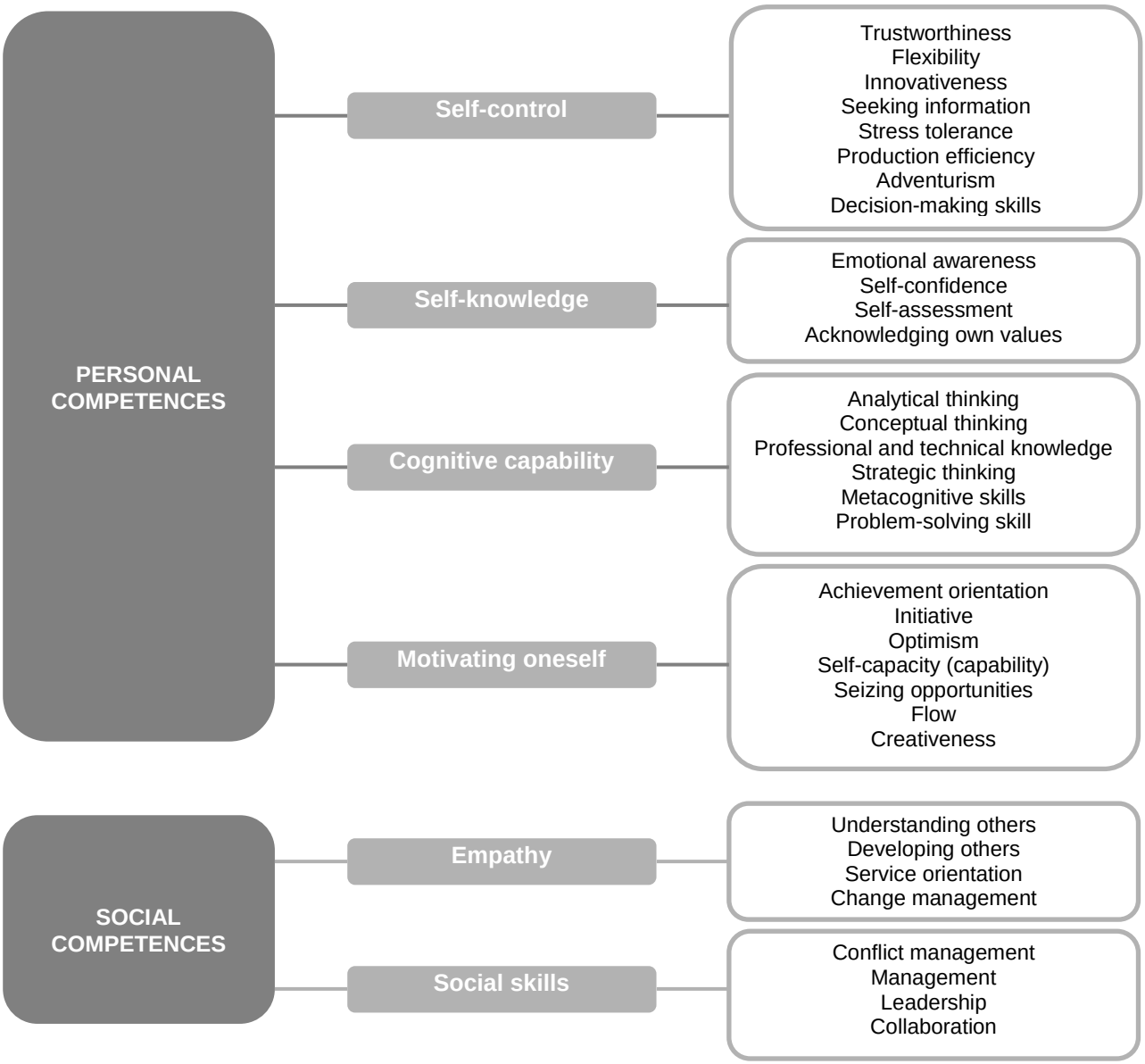
Table 1: Positioning of Spanish universities in the Academic Ranking of World Universities 2010

Institution*	National Rank	Regional Rank (Europe)	World Rank
Autonomous University of Madrid	1-4	75-123	201-300
Complutense University of Madrid	1-4	75-123	201-300
University of Barcelona	1-4	75-123	201-300
University of Valencia	1-4	75-123	201-300
Autonomous University of Barcelona	5-7	124-168	301-400
Polytechnic University of Valencia	5-7	124-168	301-400
University of Pompeu Fabra	5-7	124-168	301-400
University of Granada	8-10	169-204	401-500
University of Santiago Compostela	8-10	169-204	401-500
University of Zaragoza	8-10	169-204	401-500

* Institutions within the same rank range are listed alphabetically.
Source: Academic Ranking of top 500 World Universities

Fig. 1. The model *Tricuspoid – Entrepreneurs' competences*



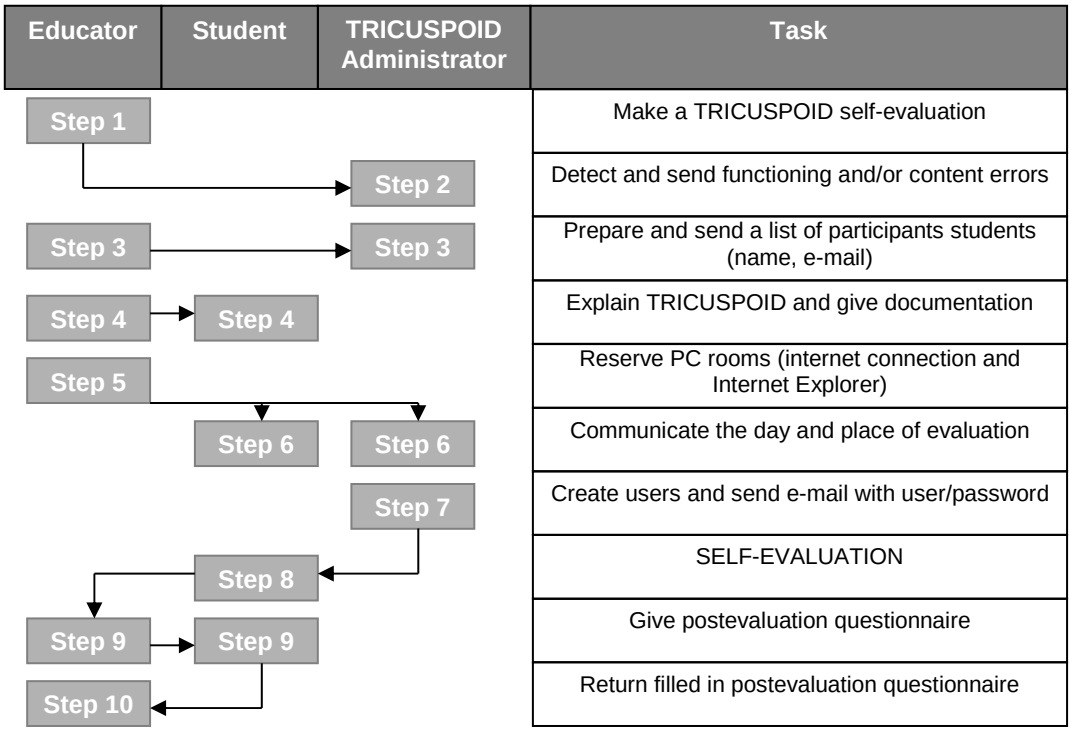
Source: Palonen (2005)

Table 2. Educational activities explicitly aimed at developing mastery of the generic competences within the UB's Master in Creation and Management of New Technology-Based Firms.

Case methodology
Students learn by confronting real problems or simulations. The case method starts with the presentation of situations or problems (cases) to a group. Normally drawn from reality, the cases are studied and analyzed. Participants exchange ideas and look for effective solutions. The purpose of the activity goes beyond the conclusions reached by the participants. Learning is produced during the process of discussion as students actively engage with the various contingencies that need to be understood.
Seminars on specialization and advanced methods
The academic program of the Master's includes seminars held throughout the year. The seminars are organized to generate discussion around the experiences of entrepreneurs, specialists and executives of interest at the Master's level. A good example is the seminar on companies from emerging sectors, which involves appearances by executives and founders of various firms in emerging, creative or innovative sectors. The students gain firsthand knowledge of the experiences of founders and executives who have set up or guided the growth of new firms.
Outside visits to firms, science parks, centres of innovation, etc.
Outside visits also serve to supplement and enrich the specific education of students. For example, visits to technology centres, research centres and science parks bring students into direct contact with the reality of these institutions and enable them to interact with experts and executives in science and technology parks, technology institutes, research centres and similar efforts connected to the Catalan innovation network.
Final Master's project
The final Master's project is an original effort addressing subject matter within the Master's program. The first step is to choose and define a significant problem or issue for study. The problem or issue may be theoretical, applied or mixed in nature. Students need to make use of the appropriate analytical tools and obtain results and draw conclusions corresponding to their analysis.

Source: Present authors

Fig. 2. Methodology applied in the project



Source: Adapted from Bikfalvi et al. (2007)

Table 3. Profile of students who completed the self-assessment with *Tricuspoid*

Gender	
Male	9
Female	9
Total	**18**
Nationality	
Spanish	9
Other	9
Total	**18**
Age (years)	
< 25	1
25-30	11
30-35	5
> 35	1
Total	**18**
Current employment status	
Full-time student	4
Part-time work	5
Full-time work	9
Total	**18**
Experience of self-employed work	
None	10
< 3 years	6
3-5 years	2
> 5 years	0
Total	**18**
Prior entrepreneurial knowledge	
Have attended a course about setting up in business	10
Have not attended any course about setting up in business	8
Total	**18**
Business tradition in the family	
Have relatives with their own business	12
Do not have any relatives with their own business	6
Total	**18**

Source: Present authors

Table 4. Variations in student competences (ranked by size of variation in creative tension)

	Initial self-assessment (October 2009)	Final self-assessment (July/September 2010)	Variation	Analysis of Variance
Competences	**Initial creative tension**	**Final creative tension**	**Variation in creative tension**	**F Statistic Anova**
Production efficiency	0.2141	0.0771	-0.1371	12.301 **
Metacognitive skills	0.2649	0.1297	-0.1352	5.989 *
Decision-making skills	0.2234	0.0897	-0.1337	8.759 **
Analytical thinking	0.2097	0.0821	-0.1276	7.067 **
Innovativeness	0.2278	0.1046	-0.1231	5.817 *
Conflict management	0.2144	0.0988	-0.1156	0.748
Initiative	0.1856	0.0774	-0.1082	8.002 **
Stress tolerance	0.2635	0.1600	-0.1035	4.155 *
Service Orientation	0.1686	0.0860	-0.0825	3.121
Understanding others	0.2447	0.1642	-0.0805	1.388
Achievement orientation	0.1857	0.1063	-0.0794	2.840
Problem-solving skills	0.1767	0.0986	-0.0781	2.824
Optimism	0.1612	0.0849	-0.0763	3.910
Self-assessment	0.2071	0.1343	-0.0729	2.253
Trustworthiness	0.0986	0.0304	-0.0682	6.718 **
Management	0.1806	0.1144	-0.0663	1.280
Strategic thinking	0.1635	0.1001	-0.0634	2.076
Professional & technical knowledge	0.1820	0.1339	-0.0480	2.242
Change management	0.1724	0.1272	-0.0452	7.294 **
Flexibility	0.1163	0.0712	-0.0452	1.336
Leadership	0.1505	0.1109	-0.0396	0.699
Seeking information	0.0710	0.0380	-0.0330	0.911
Acknowledging own values	0.0990	0.0693	-0.0296	0.537
Seizing opportunities	0.0747	0.0463	-0.0284	0.673
Developing others	0.0832	0.0638	-0.0193	0.532
Adventurism	0.0275	0.0149	-0.0126	0.128
Collaboration	0.0801	0.0677	-0.0124	0.042
Emotional awareness	0.0117	0.0031	-0.0086	0.054
Self-confidence	0.0273	0.0233	-0.0039	0.008
Creativeness	0.0487	0.0454	-0.0033	0.012
Conceptual thinking	0.1078	0.1119	0.0042	0.007
Self-capacity (capability)	-0.0585	-0.0327	0.0258	0.839
Flow	-0.0332	0.0506	0.0839	4.059

*Significance level: ** 99% and * between 99 and 95%*
Source: Present authors

Table 5. Variations in clusters of competences (ranked by creative tension)

	Initial self-assessment (October 2009)	Final self-assessment (July/September 2010)	Variation	Analysis of Variance
Clusters of competences	**Initial creative tension**	**Final creative tension**	**Variation in creative tension**	**F Statistic Anova**
Self-control	0.1553	0.0732	-0.0820	11.403 *
Cognitive capacity	0.1841	0.1094	-0.0747	5.317 *
Social Skills	0.1564	0.0979	-0.0584	1.726
Empathy	0.1672	0.1103	-0.0569	2.279
Self-knowledge	0.0863	0.0575	-0.0287	0.999
Motivating oneself	0.0806	0.0540	-0.0266	1.571

*Significance level: ** 99% and * between 99 and 95%*
Source: Present authors

Table 6. Variations in main groupings of competences (ranked by creative tension)

	Initial self-assessment (October 2009)	Final self-assessment (July/September 2010)	Variation	Analysis of Variance
Main groups of competences	**Initial creative tension**	**Final creative tension**	**Variation in creative tension**	**F Statistic Anova**
Social competences	0.1618	0.1041	-0.0577	2.105
Personal competences	0.1302	0.0740	-0.0562	5.078 *

*Significance level: ** 99% and * between 99 and 95%*
Source: Present authors

Table 7. Students' evaluation of broad competences and the *Tricuspoid* tool

Groups of competences		Mean score on a scale of 1 to 7 (1: none; 7: maximum)
Importance to the student of the social and personal competences	Self-knowledge	6.44
	Social Skills	6.28
	Motivating oneself	6.11
	Self-control	6.00
	Empathy	5.72
	Cognitive capability	5.67
Students' evaluation regarding the suitability of the tool for assessing broad competences	Motivating oneself	5.50
	Cognitive capability	5.44
	Social Skills	5.28
	Empathy	5.11
	Self-knowledge	4.61
	Self-control	3.72
Students' evaluation regarding the contribution of the Master's program to the development of broad competences	Motivating oneself	5.94
	Empathy	5.83
	Self-knowledge	5.78
	Social Skills	5.61
	Self-control	5.50
	Cognitive capability	5.44

Source: Present authors