Developing tools to improve generic competences assessment: the e-Competentis project

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Abstract

This paper reports a research project carried out in order to support competency-based assessment practices which includes the creation of a public collaborative space (website http://www.ecompetentis.es). It has been conceived to be a framework for teacher's activities with assessment tools, innovation resources, research projects and a collection of good practices and experiences for generic competences assessment. We particularly describe the Spanish validation of two psychometric tools available in this education portal for assessing “teamwork” and “problem solving” as generic competences. These instruments were applied in pilot experiences to 426 engineering students in four Spanish universities.

Keywords: assessment, generic competences, education web, higher education, engineering education

1. Introduction

In the current climate in European higher education, assuring and enhancing the quality of teaching and learning is a key issue. While the accountability function of assessment and evaluation processes has acquired more importance, the priority in the majority of countries is now to ensure that professionals have the competences, instruments and feedback they need to improve their practice [1]-[2]. However, underlying the current debate about preparation of graduates for the workplace, there are several pitfalls and problems associated to the assessment and accreditation of generic or transferable competences. Assessment and evaluation build on teacher professionalism, but there are relevant constraints related to which assessment methodologies and tools would be selected to determine if students are mastering generic competences.

Despite the quickly diffusion of the competence-based learning in Europe, there is confusion and increasing criticism concerning the concept of competence (in major measure on generic or transferable competences) and its assessment [3]-[4]. From the curricular perspective, specific articulations of competences inform and guide the bases of subsequent assessments. In this sense, competences provide directions to design learning experiences and assignments that will help students gaining practice in using and applying these competences in different contexts [5]. In other words, which appropriate modes of teaching, which learning activities might best foster competences in terms of knowledge, understanding and skills; and how do we assess these competences. Biggs (2003) describes
this as the problem of the “alignment” of teaching, learning activities, and assessment with the intended learning outcomes of a course of study [6].

In this sense and in contrast with a long experiences and background in other countries, competence-based initiatives in Spain are at the early stages of development. Relatively few assessment resources/tools are available in the field and the identification of teaching existing good practices and materials is scarce. While a lot of assessment methods and quality assurance work happen locally and informally, these practices are frequently not documented and there is little evidence as to whether good practice is spread and shared across the education system. In addition, information on generic competences assessment in the Web is confusing and hardly accessible for specific use in the practice teaching. Except for some universities, there are few systematic resources and tools easily available in relation to the assessment of generic competences.

This paper sets out to describe the development of a research project financed by the Ministry of Education and Science (MEC, Ref. EA2009 – 0040) oriented to support teacher assessment activities in higher education, particularly in engineering education [7]. The project team consider that competences assessment should be based on the access to multiple and diversified sources of information with the target of determining if the students have achieved the expected outcomes level. With this purpose this project has developed a collaborative space throughout a website (http://www.ecompetentis.es) which has been conceived to be a support framework for Spanish teachers with assessment tools, innovation resources, research projects and a collection of good practices and experiences, among others. In addition, the paper describes the validation for the Spanish context of two psychometric tools for assessing generic competences. The selected competences were “teamwork”, using the Self-efficacy for teamwork and teamwork behavior questionnaire items [8] and “problem solving”, using the PSI Problem Solving Inventory [9]. Both instruments were applied to 426 engineering students in pilot experiences in four Spanish universities. The rest of the paper is organized as follows. Section 2 presents an overview of generic competences assessment and the project theoretical background, Section 3 exposes the project objectives, followed by a briefly explanation about the validation process of two selected assessment tools and, finally, the last Section comments and conclusions.

2. Theoretical approach to generic competences assessment

2.1 What means assessing generic competences?

Competence oriented education emphasizes the integrated nature of what students must learn to fulfill future demands from jobs and life. Both emphasis in input-output and the learning process is reflected in the assessment of student performance, moving from knowledge as the dominant (even the single) reference to include a variety of approaches to assessment (portfolio, tutorial work, course work; peer, co and self-assessment, etc.). Current competence based education integrates self-regulated learning, project learning, Project Based Learning (PBL), coaching learning, etc. [4]-[10]. Learning, according to the latest constructivist learning theories, is essentially: (1) constructive, (2) cumulative, (3) self-regulated, (4) goal-oriented, (5) situated, (6) collaborative, and (7) individually different [11]. The learner is an active partner in the process of learning, teaching and assessment. Student perceives, selects, interprets, and integrates new information to form a coherent and meaningful whole with her/his prior knowledge and experiences. These changes in learning theory go together with innovations in instruction and evaluation: new instructional methods are introduced in educational practice, the latest technologies and media are used, and alternative modes of assessment should be implemented [12]. Assessing competences is related to find out what the students know (knowledge), what the students can do, and how well they can do it (skill; performance), how students go about the task of doing their work (process) and also how students feel about their work (motivation, effort and perceptions). In this sense, Mansfield contrasts three different
usages of competence: outcomes (for example, vocational standards describing what people need to be able to do in employment); tasks that people do (describing what currently happens); and personal traits or characteristics (describing what people are like) [13]. These statements are applicable to both specific and generic competences.

The concept of generic or transferable competence is strongly associated with the ability to master complex situations and for this reason it is assumed that “competence” transcends the levels of knowledge and skills to explain how knowledge and skills are applied in an effective way [14]. Generic competence includes high-order abilities related with being able to learn, adapt, anticipate and create in a diversity of knowledge areas, rather than with being able to demonstrate that one has the ability to do.

In the majority of European countries competence is considered a holistic combination of knowledge, skills, abilities and attitudes appropriate to a particular situation. It is a complex “knowledge in action”, resulting from integration, mobilization and fitting of many capacities and skills (which may be of cognitive, emotional, psychomotor or social nature) and of knowledge (declaratory knowledge) effectively used, in different contexts [15]. In the project “Tuning Educational Structures in Europe” (p. 280), competence is defined as “a dynamic combination of attributes - with respect to the knowledge and its application, to the attitudes and responsibilities that describe the results of learning a determined program, or how the students will be able to develop at the end of the educative process” [16]. This concept embraces integration between specific and generic competence.

From these conceptual perspectives the e-Competentis project was designed and developed using the Roe’s “architectural competence model” [17] as a guide for combining assessment methods that we consider appropriated for generic competence assessment (see Fig. 1). Three complementary approaches to competences assessment was proposed considering this model, focusing on the individual (considering personality traits), on the activities development (during all the learning process, including knowledge, skills and attitudes) and the final results/final outcomes (for example, the “products” of a project).

Figure 1. Adapted from Roe’s architectural model of competences
Generic competences are interrelated with specific ones and both rest on the pillars of knowledge, skills, and attitudes. This whole structure is built upon the individual person’s dispositions, i.e., abilities, personality traits, interests, values, among other characteristics.

2.2 Pitfalls and constraints in generic competences assessment

In the teaching practice generic competences are generally interpreted in the light of the disciplinary area. Even in cases in which the graduates will almost certainly be expected to work in areas not directly related to the subject where they will receive a degree, the academics’ perception of the generic competences remains quite tightly tied to the subject area disciplines themselves. For this reason, for each generic competence a distinction must be made between disciplinary areas in which the competence is considered important or even fundamental, a priority for the discipline, and those in which its connection with the subject area is less clear. Another important aspect is the curricular treatment of generic competences. Across Europe, there are two main ways of teaching or embedding generic competences:

a) These competences can be considered as part of a degree program, of separate course units/modules to enable students to master at least part of the generic competences. In this respect one could think of, for example, communication competences (writing and oral skills) and ICT competences.

b) Generic competences also can be developed as part of or integrated into subject programmes and modules.

It is striking to see how differently some generic competences have been understood in the context of the various subject area groups. Sometimes strong differences can be noted between different national traditions within a single subject area. However it is more common to observe strong differences in perception and methods between different subject areas [17]. And maybe even the most important difficulty for competences assessing is that competences cannot be directly observed in all its complexity, they can be inferred from behavior and performance and require planning actions that will gather evidence, in quantity and quality sufficient to make reasonable judgments about them. Students are the protagonists in the assessment processes. In words of Knight (1995) “students often don’t know why the system is as it is, or how they are meant to do something. Basic questions remain unanswered, for example, ‘What skills am I being assessed on?’, ‘Why do we have exams? Students have numerous doubts regarding the reliability, validity and effectiveness of assessment, as well as the degree to which it contributes to the learning process” [18].

2.3 Generic competences assessment: from summative to formative assessment

A literature review shows the following multiple purposes of assessment:

- **Summative assessment**: which aim is to monitor educational progress or improvement. Educators, policymakers, parents and the public want to know how much students are learning compared to the standards of performance or to their peers.

- **Formative assessment (or assessment for learning)**: which aim is to provide teachers and students with feedback. Teachers can use the feedback to revise their classroom practices, and students can use the feedback to monitor, reflect and improve their own learning.
• **Accountability assessment**: this third purpose of assessment is to drive changes in practice and policy by holding people accountable for achieving the desired reforms.

For Scriven, who introduced the concept of "formative assessment", this kind of evaluation aims at providing data that permit successive adaptations of a new program during the phases of its development and its implementation [20]. According to Nicola and Macfarlane-Dickb (2006) formative assessment refers to assessment that is specifically intended to generate feedback on performance to improve and accelerate learning. A central argument is that, in higher education, formative assessment and feedback should be used to empower students as self-regulated learners [19]. The construct of self-regulation refers to the degree to which students can regulate aspects of their thinking, motivation and behaviour during learning [21]-[22]. Formative assessment recognizes that each learner has to construct an understanding for her or himself, using both incoming stimuli and existing knowledge, and not merely absorbing transmitted knowledge [23]. These views of learning acknowledge that both students' existing knowledge and thinking processes influence the learning outcomes achieved and, therefore, both need to be taken into account in teaching and assessment. Both formative and summative assessment influence learning. In other words, to improve learning outcomes, we need to consider not only the teaching and learning activities, but also the assessment tasks [24].

Although the extent to which formative assessment improves learning outcomes is now wide being recognized and there has been much written on the importance of formative assessment to improve learning and standards of achievement, there has been little research on the process of formative assessment itself [25]-[26]. As Black and Wiliam (1998) has suggested, there is a need to explore views of learning and their interrelationships with assessment practices and tools [26]. This has been the principal aim of the project e-Competentis, which is presented in the following section.

3. The e-Competentis project

3.1 Objectives

More specifically, the general objectives of this project have been:

- The design, research and development of assessment tools for assessing generic competences in higher education,
- The elaboration of a web portal for supporting teaching activities related to generic competences assessment

As far as generic competences are concerned, this website offers: assessing tools, innovation and investigation projects and successful experiences, etc. However, eCompetentis constitutes a collaboration space and would soon provide some other instruments, projects and experiences of colleagues who are interested in participating. The portal has the following structure:

1. **Home page**, with general information and welcome.
2. **e-Competentis Project**: description of the research project.
3. Projects: contains research or educational innovation projects related to the development and assessment of transferable competences (or skills). All registered participants may post both a summary of the project and other documents or materials they wish to share with others.
4. **Instruments**: lists the available assessment methodologies, instruments and tools. These instruments can be in different formats, from a text file or pdf format to online self-assessment questionnaires immediate use of students. In the same way as in the case of projects, any registered user can enter your assessment tools.

5. **Success stories**: lists various experiences/good practices applied in the classroom that can be considered a reference or have useful input for general application. Unlike projects, experience is essential to the existence of active processes applied in the classroom. In the same way as in previous cases registered users can post their experiences.

6. **Links**: list of other web sites related to the competency assessment.

The portal is in the first stage of its development. At the present there are two psychometric instruments available for the assessment of the generic competences “teamwork” and “problem solving”, which have been translated and validated for the Spanish context.

### 3.2 Can psychometric tests contribute to generic competences assessment?

The answer to this question is “yes, of course”. Psychometrics concerned with the theory and technique of educational and psychological measurement, which includes the measurement of knowledge, abilities, attitudes, and personality traits. The field is primarily concerned with the construction and validation of measurement instruments, such as questionnaires, tests, and personality assessments. Stout (2002) has analyzed 15 years of psychometrics in educational practices, suggesting that the summative assessment testing paradigm that has driven test measurement research for over half a century is giving way to a new paradigm that in addition embraces skills level formative assessment, opening up a plethora of challenging, exciting, and important research problems for psychometricians [27]. This author affirms that “the summative assessment paradigm for testing is being supplanted by a new blended summative assessment and formative assessment paradigm” (p. 515), with sometimes the same test being used for both purposes and sometimes new tests being developed for formative assessment purposes alone.

An ample scope of generic competence assessment should include a diversity of instruments, such as personality tests, tests of knowledge or skill, oral presentations, multiple choice questions, laboratory reports, portfolios, fieldwork reports, written essays or reports, practical demonstrations, etc. When discussing assessment issues across different cultures, it is important to probe the different ideas about what should be taken into account in assessment vary. For example some systems prize hard work, others high achievement, others high potential. This underlying value system is easily forgotten in a straightforward description of what modes of assessment are used, but in a ‘mobile Europe’ is one which should be better understood [16]. In our project we have selected two generic competences.

### 3.3 Validation and research Can psychometric tests contribute to generic competences assessment?

At present we are able to offer two measurement tests to assess generic skills "Teamwork" [8] and "problem solving" [9]-[30]. For this purpose, we have translated tests and validated scheduled the trial of these meters in a pilot project. After an ample literature review we have selected the Problem-Solving Inventory (PSI) [9]-[30]-[32] and the Self-efficacy for teamwork and teamwork behavior questionnaire items [9]. To translate the tests into Spanish, diverse methods were used to ensure that content, semantic, and technical equivalence was
ascertained. For cross-cultural research, content equivalence is established by determining whether the content of each item of the instrument is relevant to the target culture. The essence of semantic equivalence is that the meaning of each item remains the same after translation into the target language. [31]

**Conceptual perspective of problem-solving competence in the e-Competentis project**

Rational problem solving is a *constructive problem-solving style* that is defined as the rational, deliberate, and systematic application of effective problem-solving skills. As noted earlier, this model identifies four major problem-solving aspects (or *sub-competences*): (a) problem definition and formulation, (b) generation of alternative solutions, (c) decision making, and (d) solution implementation and verification. In problem definition and formulation, the problem solver tries to clarify and understand the problem by gathering as many specific and concrete facts about the problem as possible, identifying demands and obstacles, and setting realistic problem-solving goals. Reeff (1999, p. 48) considers that “problem-solving is (goal directed) thinking and action in situations for which no routine solution procedure is available. The problem solver has a more or less well-defined goal, but does not immediately know how to reach it. The incongruence of goals and admissible operators constitutes a problem. The understanding of the problem situation and its step-by-step transformation, based on planning and reasoning, constitute the process of problem solving” [28]

The Problem-Solving Inventory (PSI) is a 32-item Likert-type inventory that is described by the authors as a measure of “problem-solving appraisal,” or an individual’s perceptions of his or her problem-solving behavior and attitudes [9]-[30]. The model is based on the conceptualization of problem solving as an important personality variable involving cognitive, behavioral, and affective domains.

**Conceptual perspective of team-work competence in the e-Competentis project**

Rooted in social cognitive theory, team efficacy is an extension of Bandura’s (1986) work on self-efficacy, which refers to an individual’s belief in his or her ability to accomplish a task [34]-[35].

Despite extensive attention has been paid to team efficacy, the extant research takes two different perspectives in the conceptualization of the construct, with focus on a) the team efficacy at the individual level, articulating that team efficacy is rooted in self-efficacy and thus can be reflected as the aggregation of individual perceptions of confidence on a group’s capability and b) the team efficacy as a group-level construct, representing group members’ shared belief on a group’s capabilities, resources, and constraints [36].

In this project we have considered the questionnaire proposed by Tasa, Taggar & Seijts (2007) for studying both the effects of individual-level and team-level factors on observed behaviors and the subsequent development of collective efficacy for mastering a complex team task. In their work self-efficacy for teamwork, task-relevant knowledge, and collective efficacy predicted individual teamwork behaviors (rated by peers). Table 1 summarizes some aspects of the validation process related to these instruments. Table 2 shows the comparison between the results obtained in the e-Competentis project with other studies realized in other countries [37].

(For more details information see the link http://82.223.210.121/mec/ayudas/CasaVer.asp?P=29---397).
Table 1. Comparison between results of Chan study and e-Competentis

<table>
<thead>
<tr>
<th>Description</th>
<th>Problem Solving Inventory (PSI)</th>
<th>Self-efficacy for teamwork and teamwork behaviour questionnaire</th>
</tr>
</thead>
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<tr>
<td>Cross-cultural application</td>
<td>More than 120 studies in USA, Mexico, China, Canada, etc.</td>
<td>Multiple adaptations in several countries</td>
</tr>
<tr>
<td>Concept</td>
<td>Problem solving is defined as the self-directed cognitive-behavioral process by which an individual, couple, or group attempts to identify or discover effective solutions for specific problem in everyday living. More specifically, this cognitive-behavioral process (a) makes available a variety of potentially effective solutions for a particular problem and (b) increases the probability of selecting the most effective solution from among the various alternatives.</td>
<td>Teamwork is defined in this project as the capacity for working as a member of an interdisciplinary team, with the aim of contribute to its development with pragmatism, accountability, efficiency and effectiveness, taking into account the available resources.</td>
</tr>
<tr>
<td>Sample</td>
<td>Male: 63 Female: 46 Missing data: 3 Total: 112 students</td>
<td>Male: 304 Female: 122 Missing data: 0 Total: 426 students</td>
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<td>Date</td>
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Table 2. Comparison between results of Chan study and e-Competentis research

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<th>PC</th>
<th>H-PSI</th>
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<td>28.21</td>
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<td>12.10</td>
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Where: PSC=Problem Solving Confidence ; AAS=Approach Avoidance Style; PC=Personal Control; HPSI=Heppner Problem Solving Inventory (comlet); PPSE=Problem Solving Self-Efficacy; PSS=Problem Solving Skills; M-PSI=Maydeu-Olivares/D’Zurilla Problem Solving Inventory (other study); PSE=Problem Solving Efficacy; RC=Rational Coping; DC=Dysfunctional
Coping; C-PSI=Chan (Problem Solving Inventory Chan case); AM= mean and ASD (mean and standard deviation adjusted for each scale item, respectively) and Alpha is the Cronbach coefficient.

4. Conclusion

Overall, the project has contributed to understanding and improving the generic competences assessment. We have considered the generic competences assessment with both the constructivist perspective and the renewed treatment in the light of contemporary theories of cognitive psychology. Psychometric test such as Problem-Solving Inventory (PSI) and the Self-efficacy for teamwork and teamwork behaviour questionnaire are considered as relevant tools for assessing generic competences. In particular, our results confirm that the two psychometric tools have been translated and adapted correctly for the Spanish language and that it fulfil the psychometric properties required for these instruments.

On other hand, the creation of the e-Competentis web can help to share best practices, innovative and effective assessment methods and resources in Hispanic countries, where these initiatives are practically non-existent. At the present, the portal offers contents related to the problem-solving, team-work and creativity competences, but no doubt others will be added in the future.

4. Acknowledgements

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References

1. C. A. Palomba and T. W. Banta (eds.), Assessing student competence in accredited disciplines: pioneering approaches to assessment in higher education, Stylus Pub. LLC, Canada, 2001


