

Chapter 2

SCAI: A Three-Dimension Model for e-Teaching Evaluation in Higher Education

In the context of teaching evaluation, the analyzed literature tends to focus on how interaction takes place in educational contexts and how the several ICTs are used. In addition, some authors are concerned with how the selected technology enables group dynamics and how these contribute to the student learning; example of this is the work of Wang (2008), entitled *A generic model for guiding the integration of ICT into teaching and learning*, in which the author puts forward a model of instructional design converging on three key elements: pedagogy, social interaction and technology. In truth, the teaching activities serve the primary purpose of promoting the students' learning and it may imply greater or lesser interaction within the teaching and learning process. However, the technology that will provide support to the implementation of these activities (e.g. e-learning platforms) should also be taken into account. Resulting from this, three dimensions of the evaluation object—e-learning activities—were defined, namely the Learning, the Interaction and the Technology Dimension, as described below.

2.1 Dimensions of e-Teaching Evaluation

2.1.1 Learning Dimension

Regarding the Learning Dimension, and taking into account the literature review, it seemed relevant to recover the concept of 'assessment object' developed by Hadji (1994)—this time, not as a central concept to the assessment process, but to the evaluation of teaching. This option relies on the basic assumption that teaching activities serve the ultimate purpose of learning and, consequently, they must be considered as an inmost part of the object being evaluated. Consequently, parallelisms at the theoretical/conceptual level are established, i.e., between what Hadji (1994) defines as 'assessment object' as to the assessment of the students' learning

and what will be considered as ‘evaluation object’ in this study regarding the evaluation of e-teaching activities.

Hadji (1994) assumes that the assessment of the student’s learning should focus, on the one hand, on knowledge and products of thought and, on the other hand, on methods and capabilities. Based on this, the author (Hadji 1994) puts forward a representation of the learning domains, taking into account the learning products and processes. For Hadji (1994), the products of thought, as representations of the contents at the conceptual level, are part of the ‘conceptual domain’. Besides, the ‘capacities domain’ includes the student’s processes of thought, and the ‘learning contexts domain’ relates to functional contextualized competences. Additionally, there may not be a direct correspondence between the assessment objects and the teaching objectives outlined by the teacher, since each of the latter can be translated into manifold assessment objects (Hadji 1994). Also according to Hadji (1994), the variety of objects can be located according to two axes: the concrete/abstract axis—the separation between what is expected behavior and observable performance—and the functional/structural axis—the separation between processes and products of thought. On both axes, the author structured the three domains mentioned: concerning the first axis (concrete/abstract), Hadji (1994) categorizes the ‘conceptual domain’ and the ‘capacities domain’ as abstract and the ‘learning contexts domain’ as concrete; in what regards the second axis (functional/structural), Hadji (1994) places the ‘conceptual domain’ as functional, the ‘capacities domain’ as structural and ‘learning contexts domain’ as both structural and functional. Finally, the learning objectives of each domain are translated into assessment objects at various levels: the ‘conceptual domain’ at the content level (in the field of concept representation), the ‘capacities domain’ in terms of intellectual or cognitive operations level (in the field of instrumental know-how) and the ‘learning contexts domain’ at a level of socially significant tasks and social competences (in the field of applied know-how) (Hadji 1994).

Several authors (e.g. Boud 2007; Kvale 2007; Zhu et al. 2008) argue, implicitly or explicitly, that the teaching activities to adopt (especially as to assessment) should focus primarily on the ‘learning contexts domain’, since it is considered that the teaching/learning activities will be more meaningful for the students’ professional future. Actually, one of the central issues in the Bologna Process, which has a direct impact on the design of the teaching activities to be adopted in a particular educational context, is the teaching paradigm underlying it. Indeed, in the HE context, it is strongly advised to implement models that embrace the development of manifold competences, depending on the learning objectives defined and scientific area, to enhance applied know-how. In fact, this approach is grounded, in terms of the teaching model, on the constructivist paradigm,¹ i.e., learning is seen as a process in which the students have an active role, since it is expected that they build new knowledge by reconstructing previously consolidated knowledge (Michelsen 2003). Wilson (1996, p. 5) adds that a constructivist learning environment is “a place where

¹The constructivist learning theory has as main precursors Bruner (1960) and Ausubel (1968).

learners may work together and support each other as they use a variety of tools and information resources in their guided pursuit of learning objectives and problem-solving activities”.

Still, it is believed that the emphasis on the importance of adopting a constructivist teaching and learning paradigm does not, and should not, exclude the role of the theoretical/conceptual component at this education level (HE); on the contrary, it should be reinforced, once the practical application of theoretical concepts (even from an instrumental perspective) may be quite relevant. Bearing this in mind, it is perfectly natural to have, for example, teaching activities that only include the conceptual domain, but may be complemented with other activities taking the development of knowledge construction to higher levels—this leads, then, to the non-exclusion of any of the three domains described above.

However, concerning the terminology adopted by Hadji (1994) for the concept of ‘capacities domain’, ‘competences’ was chosen over ‘capacities’, once the latter is considered far less rich and comprehensive than the former. In other words, the concept of ‘competences’ appears much closer to the notion of knowledge and ability to do something well; and moreover, it is widely used in most of the legislation concerning HE,² as well as by the academic community working upon HE (Barajas and Gannaway 2007; Cardoso et al. 2003; Combs et al. 2008). Consequently, ‘Competences Domain’ will replace the term ‘Capacities Domain’. Likewise, the term ‘Learning Contexts Domain’ will also be renamed as ‘Applied Competences Domain’, since it clarifies the distinction (and proximity) between this domain and the previous one. In short, the ‘Competences Domain’ will be centered on intellectual or cognitive operations in the instrumental know-how field, and the ‘Applied Competences Domain’ on socially significant tasks, or social competences, in the applied know-how field. Having presented Hadji’s (1994) proposal and defined the terminology to be used in this work, it is now time to justify the parallelism established between the conceptual representation of the assessment object (presented by Hadji 1994) and the evaluation object of e-teaching.

First, it is relevant to recover the assumption that there may not be a direct correspondence between the evaluation objects and the educational objectives. In fact, a teaching activity is not always designed to achieve a single educational objective; instead, there is often more than one activity to achieve an objective and many activities come to be transversal in the sense that they are intended not only to the fulfillment of more than one educational objective, but also as the development of competences that are often systemic or macro-competences of the course that subject integrates (Gosling and Moon 2001). Indeed, in Hadji’s (1994) representation, it was not possible to discern inter-relational dynamics among the multiple domains. Still, when teaching activities are put into practice, there is often an interpenetration of the three domains (Fig. 2.1). For instance, on the one hand, it is not hard to imagine that, within a propaedeutic subject, in a first moment, teachers define more conceptual teaching activities for students to structure their theoretical knowledge as to a particular topic (Conceptual Domain), followed by activities involving the

²For example in the document of the Commission of the European Communities (2000b)—*eLearning—Designing tomorrow’s education*.

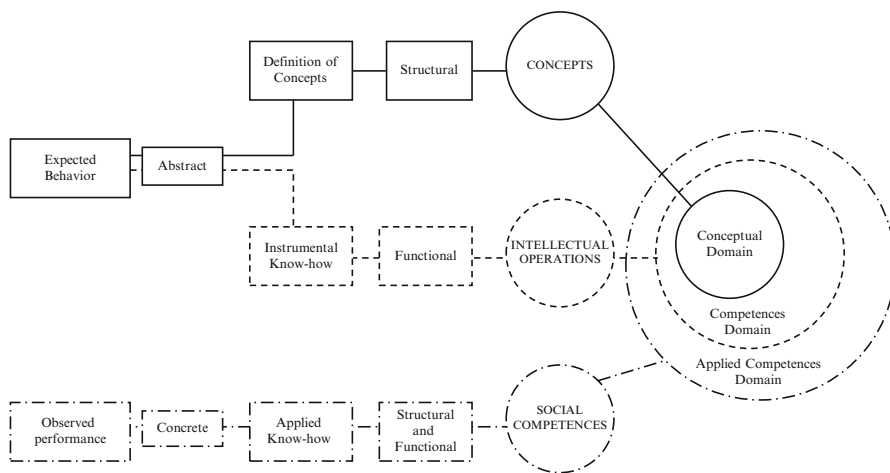


Fig. 2.1 Representation of the learning dimension: conceptual domain, competences domain and applied competences domain (based on Hadji 1994)

instrumental operationalization of the new knowledge (Competences Domain). On the other hand, after this activity, the teacher may resort to other teaching activities that tend to belong to the ‘Applied Competences Domain’, e.g., in order to verify the practical applicability of the knowledge built from a theoretical point of view or even to address real problems to restructure and enrich prior cognitive structures³ *a posteriori* (Conceptual Domain), promoting “the development of higher order cognitive skills like reflection and metacognition, increasing self-directed learning skills” (Redecker 2009, p. 7).

In Fig. 2.1, an adaptation of Hadji’s (1994) conceptual framework is put forward, for the context of teaching evaluation. It aims to differentiate three main types of evaluation objects—at the level of concepts, of intellectual operations and of social competences/significant tasks. These typologies culminate in the definition of three domains (Conceptual Domain, Competences Domain and Applied Competences Domain), which can be seen as independent, but not as hermetic since they are not mutually exclusive (Fig. 2.1).

Resulting from the abovementioned, it is assumed that the teaching activities should be evaluated taking into account the students’ expected behavior (abstract) and observed performance (concrete). Again, some constructive principles behind this division are identified. In other words, the process of knowledge internalization is critical for the human development and, before starting an intra-psychological process of knowledge restructuring of prior cognitive structures, the individual internalization involves an external inter-psychological activity (with the other).

³The term ‘cognitive structure’ is understood as a mental tool that enables the understanding of new realities, i.e., as a result of the organization of thoughts, feelings and actions in the process of building the personal meaning of an experience that allows individuals to make sense of new experiences.

Therefore, learning is developed cyclically from the concrete—regarding what is outside the individual—to the abstract—as individual mental action (Tharp and Gallimore 1988). This conceptualization (on the way new knowledge is constructed) reinforces the importance of developing teaching activities that are based on real problem solving, that are, as much as possible, sustainable and authentic and that support a consistent reorganization of prior cognitive structures.

In the literature, the adjective ‘sustainable’ appears generally associated to the concept of ‘(learning) assessment’ (Boud 2000). However, in terms of teaching activities in general, it seems to come fully in line with what is recommended by the Bologna Process. Thus, to characterize the teaching activities as ‘sustainable’ (Boud 2000⁴) means that these should meet the current teaching and learning needs, preparing students for future obstacles in their professional lives. This understanding of teaching activities will necessarily promote what is expected from HE, for instance, in terms of Lifelong Learning (Commission of the European Communities 2000a; European Economic and Social Committee 2006).

Similarly, some authors use adjective ‘authentic’ to characterize, not only ‘assessment activities’, but also ‘learning activities’ in general (Lebow 1993; Newman et al. 1996; Perreault 1999). Consequently, ‘authentic learning activities’ are those that occur in real and relevant learning contexts and that focus not only on solving but also on tackling new problems (Barnet 2007; Herrington et al. 2007; Kvale 2007). However, Woo et al. (2007) present the main characteristics that characterize authentic activities, i.e., among other things, they should:

- be relevant to the real world;
- not be too hermetic, allowing the student to make choices to complete the task successfully;
- include complex tasks;
- allow the student to equate the tasks associated with each activity from various points of view and using manifold information sources;
- promote collaboration and critical thinking;
- integrate evaluation;
- and lead to the production of valid products.

Nevertheless, it determinant to bear in mind that the choice of a teaching activity should always take into account the learning objectives as well as the environment in which it will occur—face-to-face or online. Some authors, such as Wilson and Scalise (2006), point out that there are not better or worse teaching activities, but more or less adequate activities to achieve specific educational purposes. This assumption should not be overlooked when outlining the teaching activities to adopt, since, as stated by Wilson and Scalise (2006, pp. 636–637), “[...] effective assessment practices can play a powerful role in the learning experience, moving an

⁴Boud (2000) draws an analogy between the concept of ‘sustainable assessment’ and of ‘sustainable development’, the latter closely linked to the political context and to the protection of the environment, and understands that something is ‘sustainable’, when it meets present needs without compromising the ability of future generations to meet their own needs.

average student, for instance, to the top third of the class—but only if certain conditions are satisfied. Student tasks needed to be aligned, or on target, with learning objectives, and students need to receive meaningful and timely feedback on their performance, as well as targeted follow-up work”.

Although in the above quote the authors refer specifically to the assessment of the students’ learning, this idea can again be generalized to various teaching activities, i.e., it must be assumed that the teaching activities condition the learning success. Furthermore, the student interaction with the teacher and the way the former performs the tasks proposed are also quite relevant issues (Pombo et al. 2013; Wilson and Scalise 2006), which will be further explored in the next section.

2.1.2 Interaction Dimension

The definition of the Interaction Dimension emerges from the fact that interaction plays a central role in e-learning context; specially because, in the case of a non face-to-face environment, the dynamics created may be crucial for the success of the teaching and learning process. As Conole (2008) refers, the digital environment is increasingly characterized by speed and immediacy, i.e., by the ability to rapidly access to huge amounts of information combined with a plurality of communication tools and social networks. Redecker (2009, p. 9) adds that “Over the last few years, there has been an impressive take-up of social computing, i.e. applications for blogging, podcasting, collaborative content (e.g. Wikipedia), social networking (e.g. MySpace, Facebook), multimedia sharing (e.g. Flickr, YouTube), social tagging (e.g. Deli.cio.us) and social gaming (e.g. Second Life)”.

This proliferation of tools and services leads to the process of rethinking teaching and learning in HE, not only concerning the student’s and the teacher’s role, but also the integration of ICT in teaching activities—always taking into account the teaching objectives (Bielaczyc and Blake 2006; Holt and Stephen 2003; Wilson and Scalise 2006). Bielaczyc and Blake (2006, p. 50) also emphasize that there should be “a shift from teacher-directed activities to student epistemic agency, a shift from right and wrong answers to the notion of improvable ideas, and a shift from individual to community knowledge and collective responsibility.” These changes may have many implications at the interaction level, particularly in online environments, since it tends to hold students (and the community that they integrate) responsible for the creation of new knowledge and also urges the teacher to design teaching activities that sustain the whole process. Based on this, the concept of ‘interaction’ can be defined as the existence of reciprocal events that require at least two objects and two actions and that happens when these objects and events mutually influence each other (Wagner 1994). Anderson (2003a, b), for example, considers several types of interaction, namely:

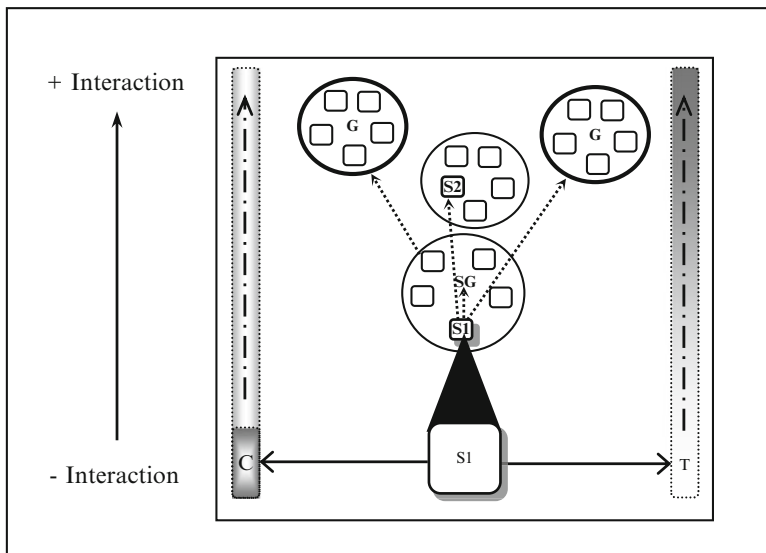
- **Student/Content**—This typology relates to the way the learner interacts with the contents and their format, for example, if the student deals with the contents in linear or exploratory ways.

- Student/Teacher—This type of interaction is intrinsically dependent on the teaching activities designed by the teacher.
- Student/Student—This form of interaction is grounded on the socio-constructivist principles that value collaboration, as well as information sharing and discussion among peers (in this case, students).
- Teacher/Content—In this interaction level, the focus lies on the role given to the teacher in the creation of learning objects.
- Teacher/Teacher—As described for the Student/Student interaction typology, it refers to the interaction of teachers with their peers to create good practices, in terms of content and ICT use.
- Content/Content—This type of interaction relates, for instance, with Internet search engines and how they respond to search terms.

Bearing in mind the brief descriptions given, the most interesting relations for the evaluation of e-learning seem to be the Student/Content, Student/Teacher and Student/Student relations. This is because, concerning the pair Teacher/Content, emphasis is given to the design of learning objects and not the way they are used, i.e., it does not take into account the teaching activities per se. Regarding the relationship Teacher/Teacher, although it is important that teachers interact with their peers to improve their performance grounded on other experiences besides their own, this relationship does not always have direct (and sometimes observable or measurable) implications in the selection of certain teaching activities over other. Finally, although teachers make an effort to manage the relationship Content/Content, in the sense they try to anticipate possible constraints that students may encounter in their learning process, the truth is that it is not always a relationship that can be completely controlled by teachers. This position is, in a way, supported by other authors (e.g. Carter and Lange 2005) when they claim that the most relevant interaction relationships are those that focus on the students and on the relationships they establish (1) with content—central issue of the Learning Dimension—, (2) with the teacher and (3) with their peers (other students).

Thus, Fig. 2.2 summarizes the interaction degrees associated with the relationships that the student can establish (1) with the contents ($S1 \rightarrow C$), (2) with the teacher ($S1 \rightarrow T$) and (3) with other students; nevertheless, in the latter four possible formats can be identified, which are summarized as follows:

- Student/Student ($S1 \rightarrow S2$)—Situation in which the student must interact with other students, individually, to share and/or discuss information.
- Student/Group ($S1 \rightarrow SG$)—When the designed activity, involves group work and students have to interact with a restricted group of students (their own group).
- Student/Other Groups ($S1 \rightarrow G$)—When the student is asked to individually participate in the work of other groups (besides the student's own group).
- Group/Group ($G \rightarrow G$)—When students, as a group, have to coordinate their work with other groups.



S1, 2 – Student 1, 2; C – Content; T – Teacher; G1 – Group 1; SG – Student's Own Group

Fig. 2.2 Representation of the interaction dimension

Thus, the interaction patterns sketched in Fig. 2.2 can be characterized as follows:

1. *Student/Content (S1→C)*

The relationship Student/Content has already been addressed in more detail in the previous section, as to the Learning Dimension, in the definition of the Conceptual, the Competences and the Applied Competences Domain, as well as the description of the dynamics that can be generated between them. Despite this, it is also relevant to include this pair ($S1 \rightarrow C$) in the Interaction Dimension (Fig. 2.2), once in this type of interaction the student acts alone with the contents, i.e., ICT are mainly used to select, share and produce information and, in particular in HE, this reality may still be predominant (Shone 2007). Moreover, the Content (C) is the common denominator for every pair represented in Fig. 2.2, since it is assumed that students always have to interact with content (individually, in collaboration ...) within every teaching activity. In short, the pair Student/Content ($S1 \rightarrow C$) represents the cases when the student interacts individually with the information, and this interaction may be included in the Conceptual, the Competences or the Applied Competences Domains (Fig. 2.1).

2. *Student/Teacher (S1→T)*

According to what is shown in Fig. 2.2, the Student/Teacher relation is also understood as transversal to the teaching and learning process, because both the

student and the teacher are essential in formal learning contexts.⁵ Furthermore, in the context of e-learning, the teacher should be seen as e-tutor, seeking to manage and moderate interactions to ensure the quality in the construction of new knowledge (Denis et al. 2004).

In some educational contexts, teachers still tend to position themselves as someone that (1) provides content (including bibliography), (2) designs activities/tasks to be undertaken by students, and (3) clarifies specific issues raised by some students (Shone 2007)—which in Fig. 2.2 is identified with the lowest interaction degree (–Interaction). Notwithstanding this, teachers can have a more active role in the students’ learning process, by giving the latter, for instance, feedback on their work or presenting them with new perspectives on the issues they are working upon.

Chatteur et al. (2008) recall that, particularly in online environment, individuals tend to interact spontaneously in informal contexts, i.e., without being encouraged through interaction (or even socialization)⁶ strategies, but the same does not always happen in formal contexts. So, the teacher should always keep in mind that the definition of interaction strategies is a necessary, but complex, task and when they are designed in a pondered way, they may lead students to engage and feel more motivated within the learning community; otherwise, they may also block interaction. Chatteur et al. (2008) put forward some suggestions for interaction/socialization strategies, namely:

- to invite students to share a brief biography;
- to create a space where students can share personal interests that go beyond the subject;
- to give feedback to students from a constructive point of view;
- to encourage students to participate in the work of other students;
- to promote the discussion and solution of real problems through collaboration ...

The application of strategies similar to the described above will necessarily lead to a higher level of interaction and, more importantly, to a more effective learning, because it is more shared and discussed (Wilson and Scalise 2006). As Pellegrino et al. (2001, p. 87) state, “Individuals acquire a skill much more

⁵Formal learning “occurs in education and training institutions and leads to recognized diplomas and qualifications” (European Commission 2000c, p. 9), as opposed to non-formal learning (which “takes place alongside the education and training systems and does not necessarily lead to formal certificates” (Commission of the European Communities 2000c, p.9)) and to informal learning, which refers to the “natural accompaniment to everyday life natural monitoring of everyday life”(European Commission 2000c, p.9).

⁶Socialization strategies are understood as strategies that lead students to share information of a more personal nature (hobbies, cultural interests ...), that some authors (e.g. Santos 2000) perceive as fundamental to address the lack of face-to-face contact in e-learning environment. In this context, the term ‘strategy’ was chosen over ‘activity’, not only because it is a term widely used by the scientific community (e.g. Chatteur et al. 2008; Pellegrino et al. 2001; Wilson and Scalise 2006), but also because the goal of such strategies is clearly set.

rapidly if they receive feedback about the correctness of what they have done. If incorrect, they need to know the nature of their mistake. It was demonstrated long ago that practice without feedback produces little learning (...). One of the persistent dilemmas in education is that students spend time practicing incorrect skills with little or no feedback. Furthermore, the feedback they receive is often neither timely nor informative. For the less capable student, unguided practice can be practice in doing tasks incorrectly”.

Thus, even though teachers can adopt a more or less passive attitude in the process, if the e-activities designed by them imply the relationship Student/Student (or any of its variants), the interaction degree tends to grow. This way, the interaction level will be found at its height when, concomitantly, (1) the e-tutor also assumes the role of moderator and facilitator of learning and (2) the combination of some (or all) variants of the relation Student/Student ($S1 \rightarrow S2$, $S1 \rightarrow SG$, $S1 \rightarrow G$, $G \rightarrow G$) is embraced through collaborative and inter-dependent work.

3. *Student/Student ($S1 \rightarrow S2$, $S1 \rightarrow SG$, $S1 \rightarrow G$, $G \rightarrow G$)*

The conceptualization presented in Fig. 2.2 also reflects what has been highlighted by Bielaczyc and Blake (2006) and Redecker (2009), in an eminently social-constructivist perspective, i.e., the need for the teaching and learning process to be student-centered, not only as an individual but as part of a community that includes the student’s peers and the teacher (Gillham 2008). In addition, authors such as Wilson (1996) stress that in e-learning context, ICTs should serve constructivist pedagogical purposes, i.e., “technologies should be used to keep students active, constructive, collaborative, intentional, complex, contextual, conversational, and reflective” (Zhu et al. 2008, p. 217). Therefore, depending on the selected teaching activity, the students’ interaction should be characterized through the relationship they establish with their peers to build new knowledge and develop competences. In this scenario, although it is not always common practice in HE context, activities involving group work, particularly in online environment, are options that should be pondered (Roberts and McInnerney 2007), since they can foster information sharing and new knowledge construction in a collaborative, and therefore, richer perspective.

In formal contexts, interaction/collaboration among students rarely happens spontaneously (on their own initiative), which means that there is a great need to plan, in advance and in detail, e-teaching activities grounded on collaborative assumptions. To this end, different types of dynamics between students can be appraised, i.e., if the student is supposed to interact: (1) with other students as an individual ($S1 \rightarrow S2$), (2) with other groups as an individual ($S1 \rightarrow G$), (3) with the elements of their own group ($S1 \rightarrow SG$) and/or (4) with other groups as a member of a group ($G \rightarrow G$) (Fig. 2.2). In fact, in terms of interaction, to choose of one of these subtypes, or even to combine more than one, strongly influences the learning process. Thus, by planning and structuring the use of the four above-mentioned subtypes ground is set for the learning process to be developed in a more collaborative way (Roberts and McInnerney 2007).

However, once again it is reinforced that the choice should be primarily based on the pedagogical objectives to be achieved in a particular educational context and the technological means available.

Returning to the authenticity issue, as to the activities to be undertaken by students in educational context, Woo et al. (2007, p. 38) point out that “To achieve a challenging authentic task, students must interact—sharing their thoughts, relating their ideas to past experiences, collaborating with their peers, actively constructing their own meaning, and incorporating the diverse perspectives of others”. Other authors, such as Merriam and Caffarella (1999) and Herrington et al. (2007), reinforce this when they claim that (un)successful learning is intrinsically dependent on the interaction degree generated within a given educational context. To sum up, concerning the Interaction Dimension, it is important to characterize the teaching activities as to the participants and to the interaction level to be achieved, taking into account the collaboration dynamics involved. Next, focus will be given to the role of ICTs in this context, namely as to their integration into the curriculum.

2.1.3 Technology Dimension

Concerning the technological aspect, the choice could have fallen on the description of the several ICTs available in the market (such as the technical characteristics, features ...); however, in the literature, there is already a wide range of rather complete works that not only describe and characterize them but also give clues about their use (e.g. *Blogs and Wiki: The Future Teachers and Web 2.0 tools* (Coutinho and Junior 2007); *Review of Learning 2.0 Practices* (Redecker 2009); *Manual Web 2.0 Tools for Teachers* (Carvalho 2008); *Second Life—Create, Produce, Import* (Moreira et al. 2009)). Faced with this, and bearing in mind that, in this study, emphasis is given to the evaluation of e-teaching activities, the chosen approach falls on the evaluation of how technology is integrated into the curriculum and the implications it may have in the learning process. The term ‘integration’ can be understood as the action of making various elements interact harmoniously for a higher-level purpose (Legendre 1993; Raby 2004). In this sense, Dias (1999, p. 11) believes that ICT integration in the teaching context happens when technology “is used in a seamless manner to support and extend curriculum objectives and to engage students in a meaningful learning”.

With this in mind, in the literature, some models for the evaluation of ICT integration in educational context were identified, that, in certain a way, relate to the object of study of this work, namely the works of Moersch (1995, 1997, 2001), Dwyer et al. (1990a, b), Raby (2004) and Florida Center for Instructional Technology [FCIT] (2007). Moersch (1995) proposes a conceptual framework to characterize the ICT implementation/integration level in education.

Moersch (1995) puts forward the LoTi Framework, in which seven levels are defined, namely: *Level 0—Nonuse*, *Level 1—Awareness*, *Level 2—Exploration*,

Level 3—Appropriation, Level 4—Integration, Level 5—Expansion and Level 6—Refinement. Thus, these levels lie between two diametrically opposite poles: the non-use (*Level 0—Nonuse*) as opposed to an immersive and creative use (*Level 6—Refinement*). At the learning and teaching level, there is also a shift from a teacher-centered to a student-centered process. In other words and as the author (Moersch 1995, p. 41) refers, “Traditional verbal activities are gradually replaced by authentic hands-on inquiry related to a problem, issue, or theme. Heavy reliance on (...) sequential instructional materials is replaced by use of extensive and diversified resources determined by the problem areas under study. Traditional evaluation practices are supplanted by multiple assessment strategies that utilize portfolios, open-ended questions, self-analysis, and peer review”.

In addition to the above, it is also important to note that the seven levels defined by Moersch (1995) is understood as a continuum that may enable education professionals to fully integrate ICT in their teaching practices; nevertheless, the potential of ICT is only truly explored from *Level 4—Integration* onwards. However, Raby (2004) points out that the last three levels (*Level 4—Integration, Level 5—Expansion and Level 6—Refinement*) are clearly designed for contexts in which problem-based teaching and learning is valued and that this type of methodology, although grounded on a constructivist perspective, may not be a viable option for every educational context.

The model proposed by Dwyer et al. (1990a, b) aims to induce changes in the teaching and learning process (in the context of the project *Apple Classrooms of Tomorrow—ACOT*), seeking that teachers alter their perspective over this process “from instruction to knowledge construction” (Dwyer 1995, p. 13), which involves changes at various levels, such as: activity, teacher role, student role, learning emphasis, concept of knowledge, demonstration of success, assessment and technology use. Indeed, concerning education, ICT integration implies a fundamental change that is embodied in the learner centrality throughout the teaching and learning process. Furthermore, the concept of ‘collaboration’ also emerges associated with the student’s and the teacher’s role in the construction of knowledge based on ICT use and emphasis is put on how the contents are interconnected and questioned rather than on its uncritical reproduction—this leads to a more qualitative, criterial and less normative⁷ evaluation of the learning process.

Dwyer et al. (1990a, b) propose a model of ICT implementation/integration in educational context that reflects (socio-)constructivist assumptions, but that distances itself from Moersch (1995) by not being necessarily grounded on problem-based learning methodologies (Raby 2004). The Dwyer et al. model (1990a) is subdivided into five levels:

⁷Landsheere (1979) explains the concept of ‘norm’ as the set of collective and common rules that serve as standards to guide the action and criteria used as a model for a qualitative comparison. In other words, normative assessment is a process guided by a set of norms and requires a comparison of learners in terms of what is considered the observable performance of an average learner and in the criterial assessment, the criterion used is exogenous to learners and to their own learning processes, since it aims to measure their performance against a given learning situation.

- *Entry*—in which “text-based technologies (e.g. textbooks, blackboards to support ‘lecture, recitation, and seat-work’” (Dwyer et al. 1990a, p. 4) are used.
- *Adoption*—when technology is used as a support to a text-based instruction, as well as for the repetition and reproduction of contents.
- *Adaptation*—at this level, technology is often used to support expositive teaching methodologies.
- *Appropriation*—when teachers have a good command of ICT and position themselves as “facilitators rather than dispensers of knowledge” (Dwyer et al. 1990a, p. 7).
- *Invention*—at this level, technological mastery of teachers already allows them to create and implement teaching strategies based on ICT use.

In turn, the synthesis-model of the ICT integration process (Raby 2004), as the author states, is inspired in the two models described above—Moersch (1995) and Dwyer et al. (1990a, b).⁸ To Raby (2004), the most relevant and complex level of ICT use is the ‘pedagogical use’. This level subdivides into five steps:

1. *Motivation*—which is closely linked with the curiosity or the need as to ICT use.
2. *Familiarization*—which relates to the development of basic competences in ICT use.
3. *Exploration*—in which ICT are seen as technological support to expositive teaching.
4. *Infusion*—which reflects an occasional use of ICT to bring students to develop specific and systemic competences in a particular educational context.
5. *Appropriation*—in which there is regular and frequent ICT use in active learning environments, so that students develop specific and transversal competences.

Actually, the great innovation brought by this model (Raby 2004) is that the five steps do not have to be understood as an evolutive continuum, since they are not mutually exclusive—to the extent that the requirements stemming from the educational context and the mastery that the teacher has of technology can dynamically position them in more than one level (Raby 2004). Finally, even if it is not very different from what Dwyer et al. (1990a, b) and Raby (2004) presented, as to the pedagogical use, the Florida Center for Instructional Technology (FCIT, 2007) presents the *Technology Integration Matrix*, which is based on the intersection between several learning environments and levels of ICT integration into the curriculum. The learning environments, which can be generated within an e-learning community, put forward FCIT (2007) are:

- *Active*—Students are actively involved in using ICT as tools and not just as passive recipients of the information provided.
- *Constructive*—Students use ICT not only to receive information, but also to build new knowledge.

⁸The author (Raby 2004) was also inspired by Morais’ (2001) model, which is not presented in this work, since the focus is on ICT use in education but in personal and professional contexts, less relevant for the present study.

- *Collaborative*—Technology is used to collaborate with other students.
- *Goal Directed*—ICT are used by students to meet pedagogical objectives, as well as to plan activities, monitor progress and assess outcomes.
- *Authentic*—Students use ICT to solve realistic problems that are meaningful to them, i.e., it refers to experiences “of personal relevance that permit learners to practice skills in environments similar to those in which skills will be used” (Woo et al. 2007).

Thus, based on the learning environment(s) intended to be generated,⁹ teachers have to define how to integrate technology into the curriculum. Regarding this, the FCIT (2007) sets five levels, namely:

- *Entry*—The teacher uses ICT to provide information.
- *Adoption*—The teacher defines the technologies to be used in tasks, as well as the specific purpose of each tool.
- *Adaptation*—The teacher allows students to choose the tools they consider most appropriate to perform a given task.
- *Appropriation*—The teacher sets tasks and its fulfillment largely depends on ICT use.
- *Invention*—The teacher designs activities that could not be fulfilled without using technology (simulacra ...).

Having defined the different learning environments and levels of technology integration into the curriculum, it is important to understand the way these two vectors are related. At first glance, it appears that when teachers only choose to define teaching activities that belong to the *Entry level*, the creation of any of the online learning environments described above will be unlikely. For instance, in the *Active learning environment*, although ICTs are used as tools, students are passive recipients of the information provided; in the *Collaborative learning environment*, its essence is lost, since this level (*Entry level*) implies that students work individually. By contrast, the use of teaching activities which fall within the *Invention level* seem to enhance the unique features of each of the learning environments described, i.e., for example in the *Constructive learning environment*, in addition to ICT being used to build new knowledge, they also serve to share and publish information online; in the *Authentic learning environment*, students are encouraged to participate in projects external to the learning context, developing activities based on real problems.

Thus, it can be concluded that, in terms of technology integration into the curriculum, the *Entry level* and the *Invention level* are located in diametrically opposite poles as to the type of interaction that can be generated, as well as the critical thinking and the autonomy that can be transferred to the students' learning process. In the first case, students are seen as receivers and, in the second case, they take over technology to develop their learning. However, the teaching activities at the *Entry level* should not necessary be excluded from e-learning contexts because sometimes

⁹ As in Raby's (2004) synthesis-model, in this model (FCIT 2007), the levels of technology integration into the curriculum are not mutually exclusive, inasmuch as the combination of their different facets may prove to be crucial to fulfil pedagogical objectives.

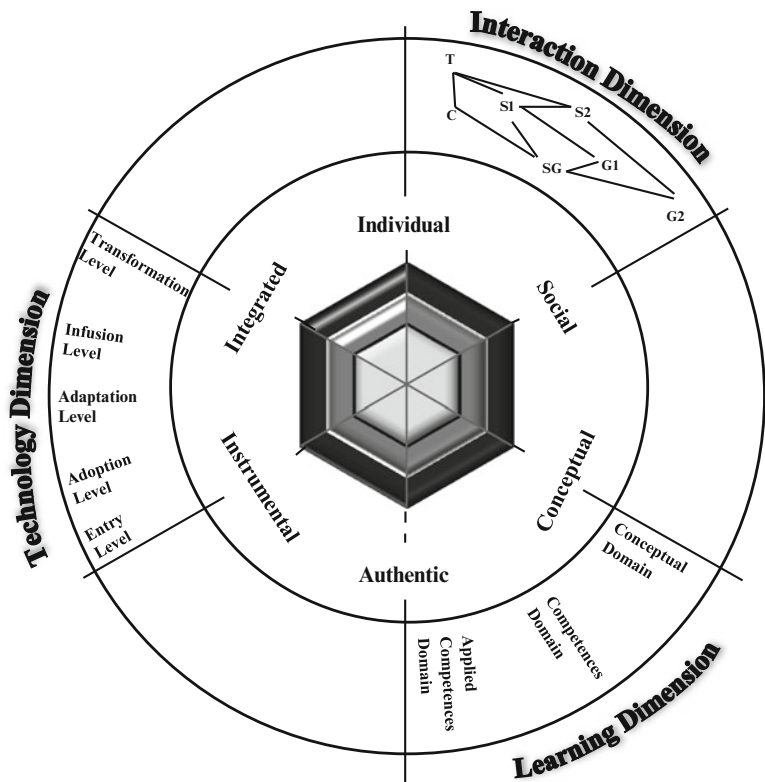


Fig. 2.3 Synthesis—model for the evaluation of e-teaching

it might be advantageous to articulate teaching activities belonging to manifold technology integration levels.

The other three levels of technology integration into the curriculum, they are considered to be of intermediate levels: at the *Adoption level*, the focus is on the use of technology defined by the teacher from an instrumental viewpoint in order to create learning products; at the *Adaptation level*, the student is given some freedom to select the tool that is more adequate to perform a task; and at the *Appropriation level*, great importance is given to the technological aspect in order to complete a certain task—being gradually given more and more autonomy to students in handling ICTs to develop their learning.

With this array of ICT integration into the curriculum, it is then clear that in e-learning context, the teacher can assign various roles to ICTs, i.e., these can be seen as tools not only to share information, but also to develop authentic and collaborative learning, in a socio-constructivist perspective; hence, in the present study and as to the Technology Dimension, this theoretical framework for evaluating e-learning activities was adopted. In short, the proposed model is based on three fundamental dimensions regarding the evaluation of teaching that are summarized in the synthesis-model presented in Fig. 2.3.

On balance, the synthesis-model put forward (Fig. 2.3) is grounded on learning domains (Learning Dimension), interaction types (Interaction Dimension) and levels of ICT integration into the curriculum (Technology Dimension), which are seen as backbone of the evaluation process of e-teaching activities. The following section depicts how these dimensions are to be implemented, namely as to the dichotomies Authentic/Conceptual, Individual/Social and Instrumental/Integrated, aiming at the creation of an evaluation matrix for the evaluation of e-teaching activities.

2.2 SCAI: Putting Theory into Practice

In order to create a tool to implement each of the three dimensions described above, the e-teaching activities that teachers could set for their subjects (Table 2.1) were typified. This because it is assumed that, within a subject, more than one type of activity can be defined, which leads to the final evaluation of the subject, based on partial results of each of the identified activities, as it will be explained later. In addition, and as shown in Table 2.1, to prevent the existence of activities not covered in the typology established, the opportunity to specify other teaching activities was also considered.

In a second phase, the participants to be included in the process were equated. The participation of teachers in the process is unavoidable, since they are the main agents in the teaching process. Furthermore, as authors like Newton (1988), Seldin (1989), Stratton (1990) and Wilson (1998) refer, the inclusion of students in the teaching evaluation process (Student Evaluation of Teaching—SET) is a phenomenon that is becoming increasingly common, in different HE institutions either as a way of evaluating the quality of teaching itself, or in terms of research done in this area. Thus, and since the teaching process exists with the sole purpose of resulting in learning, the inclusion of the students’ perception of the (online or face-to-face) teaching process seems to be essential for the evaluation results to depict the reality faithfully.

In what concerns the way the teaching evaluation process is put into practice, Pounder (2007) points out that it tends to translate into the students evaluation of the teachers’ performance and their comparison with the students outcomes. Despite this, most of the research, in which these two factors are taken into account, reveals that the correlation between the students’ outcomes and the way they evaluate their

Table 2.1 E-teaching activities: typologies

Types of teaching activities
Analysis of the information provided by the teacher
Information research, selection and/or synthesis
Individual exercises
Individual work
Group work
Other. Which?

teachers' performance is not very significant (Cohen 1983; Damron 1996; McCallum 1984; Pounder 2007). Consequently, in this study, the evaluation focus is not on measuring the teacher's performance level, taking into account the students' satisfaction with teaching process (e.g. as to clarity, how the issues are addressed, etc.), since it is considered to be more interesting to evaluate teaching according to the aspects valued in the design of the activities proposed to students (teachers' perspective) and its implementation (students' perspective), as it will be described below. To better understand this section, please note that its main goal is to try to show how the two tools of e-teaching evaluation (one aimed at teachers and other at students), as well as respective reading matrices, were built, allowing for an evaluation by subject and also by course, as it is described.

2.2.1 SCAI: Overall Evaluation of e-Teaching Activities

In terms of subject, two perspectives were considered—the teachers' and the students'—and for each of them some variables were defined by Dimension, as well as data reduction techniques and reading matrices to analyze the evaluation results.

2.2.1.1 Teacher's Perspective

1. Learning Dimension

As to the Learning Dimension, it is important to remember that the teaching (and also the learning) process is not meant to be linear or inflexible, leading to the adoption of activities that combine the 'Conceptual' and 'Authentic' aspects, even though they might be assigned different weights. Resulting from this, in the Learning Dimension, based on the 'Conceptual/Authentic' dichotomy, the '+Conceptual' aspect refers to the Conceptual Domain and the '+Authentic' aspect to the Applied Competences Domain. In addition to these, three intermediate levels are also considered: (1) one in which the theoretical aspect prevails over the practical ('+Conceptual/–Authentic'), (2) one in which both aspects are valued identically, for example, through the contextualization of the theoretical component ('Conceptual/Authentic') and (3) one in which the practical aspect surpasses the theoretical ('+Authentic/–Conceptual'). Consequently, in the evaluation tool aimed at teachers, five variables were defined in what concerns the learning that students are supposed to develop, in an attempt to uniform the teachers' possible answers (Table 2.2).

Although it might appear to be a very simplistic approach, the nuances as to the variables defined above (Table 2.2) that could be foreseen are not considered relevant, based on the assumption that the Learning Dimension Domains are not hermetic, but rather complementary. This was displayed in the definition of two hybrid typologies, which result from the combination of characteristics of two Domains,

Table 2.2 Variables of the learning dimension: conceptual/authentic (teacher's perspective)

Domains	Typologies	+C	+C/-A	A/C	+A/-C	+A
Conceptual Domain	Defining and representing theoretical concepts	X				
Conceptual Domain/ Competences Domain	Interconnecting theoretical content		X			
Competences Domain	Selecting theoretical contents to find solutions for practical problems			X		
Competences Domain/ Applied Competences Domain	Formulating hypotheses to solve practical problems				X	
Applied Competences Domain	Solving authentic/real problems					X

A Authentic, C Conceptual

namely the one that includes the Conceptual and Competences Domains and the one comprising the Competences Domain and the Applied Competences Domain (Table 2.2). In fact, the last two types are not necessarily defined by the perfect sum between the characteristics of the Domains considered; consequently, the most relevant characteristics for each of the five variables defined in Table 2.2 are:

- *Defining and representing theoretical concepts* (essentially Conceptual: +C)—This variable focuses essentially on theoretical representation and description, i.e. the learning process is understood as structural, once it works upon abstract concepts, taking into account the expected behavior.
- *Interconnecting theoretical contents* (more Conceptual than Authentic: +C/-A)—The essence of this variable is also conceptual, structural and abstract. However, the learning activities included in this typology lead students interconnect various theoretical concepts, i.e. the intellectual operation upon the constructed knowledge.
- *Selecting theoretical contents to find solutions for practical problems* (as Authentic as Conceptual: A/C)—This variable belongs to the Competences Domain, where the practical ('Authentic') and theoretical ('Conceptual') learning aspects are combined at the same level. These activities operate upon abstract knowledge, i.e. focus on cognitive operations from an instrumental point of view (instrumental know-how, valuing the functional aspect of knowledge). For example, e-teaching activities in which the teacher presents several theoretical solutions for a practical problem and the students will have to select a solution and justify their choice.
- *Formulating hypotheses to solve practical problems* (more Authentic than Conceptual: +A/-C)—This variable includes teaching activities in which the 'Authentic' (practical) aspect prevails over the 'Conceptual' (theoretical) one, and in which the student is given some autonomy in solving a particular problem. Thus, this type of activities is based on instrumental know-how, but students are supposed to take responsibility for the evolution of their own learning, inasmuch that significant tasks of a functional nature imply structural and conceptual construction of knowledge at a higher level. In other words, it deals with eminently

Table 2.3 Variables of the interaction dimension: individual/social (teacher's perspective)

Interaction	Description	+I	+I/-S	S/I	+S/-I	+S
S1→C	Student individual reflection	X				
S1→D	Facilitation and moderation of learning		X			
S1→S2	Student→Student(s) information sharing		X			
	Student→Student(s) interaction			X		
S1→SG	Student→ Student's own group interaction				X	
S1→G	Student→Group(s) interaction					X
G→G	Group→Group interaction					X

I – Individual; S – Social

practical teaching activities that may lead the student to play an active role in the construction of new (theoretical) knowledge.

- *Solving authentic/real problems* (essentially Authentic: +A)—In this variable, the development of social competences in context is valued and it is based on observable performance, i.e. entails the development of applied social competencies, valuing socially significant tasks (applied know-how). Thus, the relationship between the functional and the structural aspect of learning is dynamic—not confining the structural (theoretical) aspect to the period anteceding the resolution of a problem, i.e., implying that the functional (practical) aspect enables the student to restructure and improve prior cognitive structures.

Besides, it is expected that, in a certain subject, the teaching activities chosen include more than one of the variables described above from a complementary viewpoint.

2. Interaction Dimension

Regarding the Interaction Dimension, the manifold relationship types presented above (S1→C, S1→T, S1→S2, S1→SG, S1→G and G→G), were included in the several variables, taking into account the Individual/Social dichotomy¹⁰ (Table 2.3).

As presented in Table 2.3, the interaction types can be represented as to their Individual/Social aspect; because they heavily depend on how an e-teaching activity is put into practice. In addition, there are several e-teaching activities that combine the interaction of several pairs. For instance, in cases where the teacher determines that the student should develop group work and the product of this work should reflect the student's articulation/negotiation with other groups—this activity type may involve S1→SG, G→G and even, S1→S2 or S1→G interaction.

¹⁰ The term 'Collaborative' was considered instead of 'Social', as opposed to 'Individual'; however, and as it can be seen in Table 2.3, some of the strategies could have a small social aspect but not be considered collaborative strategies.

Table 2.4 Variables of the technology dimension: instrumental/integrated (teacher's perspective)

LTIC	Description	+Inst	+Inst/-Int	Int/Inst	+Int/-Inst	+Int
Entry	Sharing information	X				
Adoption	Using predefined tools to accomplish tasks		X			
Adaptation	Selecting tools to accomplish tasks			X		
Infusion	Articulating several tools to accomplish tasks				X	
Transformation	Accomplishing tasks that could not be fulfilled without using technology					X

LTIC- Levels of Technology Integration into the Curriculum, *Inst* – Instrumental, *Int* – Integrated

3. Technology Dimension

As to the Technology Dimension, the approach is similar to the one adopted for the Learning Dimension, once it was sought to define levels of technology integration into the curriculum (based on levels defined by FCIT (2007)) and associate them to the five categories grounded on the Instrumental/Integrated dichotomy (Table 2.4).

As shown in Table 2.4, the *Entry level* is located in the ‘Instrumental’ (+Inst) pole, since it refers to e-teaching activities in which ICT are mostly used to share information. In other words, the use of ICT does not necessarily lead to the construction of new knowledge. In contrast, any e-teaching activity that belongs to the *Transformation level* implies that ICT use is crucial to develop the proposed activities, placing them in the ‘Integrated’ (+Int) pole.

In addition to the aforementioned, intermediate categories were created, that identify the remaining levels of technology integration presented above, namely:

- at the *Adoption level*, the ‘Instrumental’ aspect is more valued than the ‘Integrated’ (+Inst/-Int), since the student has no control over the tools that they can use to perform a particular task;
- at the *Adaptation level*, the ‘Instrumental’ and ‘Integrated’ aspects have identical weights (Int/Inst) because the students can select the tool they will use to accomplish a task and customize its use;
- at the *Infusion level*, the ‘Integrated’ aspect is more valued than the ‘Instrumental’ (+Int/-Inst), since the use of ICT is mandatory to fulfill these e-teaching activities.

Again, a certain activity can integrate tasks that require different levels of technology integration into the curriculum, which led to the development of a reading algorithm to reduce the data gathered in order to assign a single category to each e-teaching activity, as described below.

The Teacher's Answers: Data Reduction

Indeed, given the diversity of e-teaching activities that can be designed within a subject, it can be easily foreseen that, for a single activity, several variables may be identified in each of three Dimensions defined and, since each variable corresponds

to a category, it was necessary to design a reading algorithm for the data collected, so that a single final category could be identified for each Dimension, but not detracting the collected data.

Looking at the Interaction Dimension, it seems more complex than the remaining dimensions because each interaction type does not necessarily exclude the other (Table 2.3); consequently, the solution found was to try to identify the dominant type in a given e-teaching activity. However, after testing this hypothesis with various activities, the conclusion was that this solution was not convincing. Consider, for example, the following case:

E-teaching activity:	Students are asked to develop an individual work and, besides, they should also share online with their colleagues the bibliography found/used
Interaction types:	S1→C (individual work) and S1→S2 (sharing documents online)

In this case, regarding the Interaction Dimension, it may be reasonable to assume that the tendency would be to identify the relationship Student/Content (S1→C) as the dominant interaction type, which means that this would be classified as ‘Individual’—+I (Table 2.3). This would lead to large biasing of the results, since the ‘Social’ component exists and may even play a relevant role in the learning developed by students. Thus, it is considered more appropriate to start by identifying every interaction type associated with a specific teaching activity and seek to translate them in the results of the evaluation of the e-teaching activity.

Taking into account the constraints above illustrated and since they are transposable to other Dimensions in their specificities, the technique that seemed to be the most appropriate was to map the foreseen responses in the scales: +C, +C/−A, A/C, +A/−C and +A for the Learning Dimension; +I, +I/−S, S/I, +S/−I and +S for the Interaction Dimension; +I, +I/−S, S/I, +S/−I and +S for the Technology Dimension. Thus, the binary values 0 and 1 were used, with the logic level 0 corresponding to the exclusion of the attribute and 1 to its inclusion. Subsequently, in cases where it was identified more than one category for the same e-teaching activity, within each of the three scales, the OR logic function (f(OR)) represented BIT to BIT¹¹ was used, as it is shown below.

The OR logic function (Table 2.5) runs over two BIT patterns of equal length (AB) and produces another pattern of equal length (f(OR)), since this is an inclusive operation of the first over the second, and so on. This way, whenever one of the patterns (A or B) includes the binary value ‘1’, in the final pattern that results from applying OR logical function (f(OR)), the value ‘1’ remains. In Table 2.6 an example of the function for the above mentioned teaching activity is provided, taking into account the Interaction Dimension.

Thus, concerning the example presented in Table 2.6, it is an activity with a strong ‘Individual’ (+I) aspect, but in which the ‘Social’ aspect is also explored (+I/−S). Having found the function that gathers information on the interaction levels that characterize a certain teaching activity, it is now important to place the activity in only one of the five categories established for each Dimension (Table 2.6). In

¹¹ A BIT (Binary DigiT) represents one of the possible binary values −‘0’ or ‘1’.

Table 2.5 OR logic function—
f(OR)—represented BIT to BIT

A	B	f(OR)
0	0	0
0	1	1
1	0	1
1	1	1

Table 2.6 Explanation of how the function of a teaching activity is calculated, when more than one category is assigned

Teaching activity	Interaction	Description	+I	+I/-S	S/I	+ S /-I	+S
Individual work	S1→C	Student individual reflection	1	0	0	0	0
Sharing bibliography online	S1→S2	Information sharing Student→Student(s)	0	1	0	0	0
Function (f)			1	1	0	0	0

order to identify the level that more faithfully translates reality, a set of general principles was drawn, so that a final category could be assigned to the e-teaching activity, which applies to every dimension, namely:

1. When only two categories are identified, the final category should correspond, when possible, to an intermediate level (e.g.: $(+I) + (-S) = +I/-S$; $(+I) + (+S) = S/I$; $(+S) + (-I) = +S/-I$).
2. Whenever the two aspects are identified in one of the three scales considered ('Conceptual'/'Authentic', 'Individual'/'Social', 'Instrumental'/'Integrated') these should always be included in the final classification, regardless of their relative weight (e.g.: $(I) + (-S) = +I/-S$; $(-I) + (-S) = S/I$; $(S) + (-I) = +S/-I$).

In addition, the several attributes were coded from A to E, and each of these letters represented a category for each Dimension, as presented below (Table 2.7).

Thus, in particular, in relation to the Interaction Dimension, the final category has to reflect various types of interaction with the same rating, when these are identified. In consequence, the option was to apply Boolean functions in order bring together the partial attributes of a particular e-teaching activity into a single final category, truly reflecting the evaluated reality (Table 2.8).

In order to define the Boolean functions, the possible answers were mapped according to the scales used (Table 2.7) and represented by binary values '0' and '1', where '0' is the value for the exclusion of the attribute and the value '1' for its inclusion.

Subsequently, to define logic functions, which characterize each of the final categories, the choice fell upon the representation of various possible combinations in binary and, furthermore, the Veitch-Karnaugh¹² method was used (Table 2.8).

¹²The Veitch-Karnaugh method (also known as "Karnaugh method") is a widely used method in the optimization of digital circuits, and as the name indicates, it had as its precursors Edward Veitch (mathematical) and Maurice Karnaugh (telecommunications engineer). It consists of a biunique mapping of the data, based on a truth table of the analyzed function, and it simplifies functions involving up to six variables, whereas in the present work, only five variables are considered per Dimension.

Table 2.7 Codification of the categories defined for each dimension

Code	Learning	Interaction	Technology
A	+C	+I	+Inst
B	+A	+S	+Int
C	+C/-A	+I/-S	+Inst/-Int
D	A/C	S/I	Int/Inst
E	+A/-C	+S/-I	+Int/-Inst

+C – essentially Conceptual, +C/-A – more Conceptual than Authentic, A/C – as Authentic as Conceptual, +A/-C – more Authentic than Conceptual, +A – essentially Authentic, +I – essentially Individual, +I/-S – more Individual than Social, S/I – as Social as Individual, +S/-I – more Social than Individual, +S – essentially Social, +Inst – essentially Instrumental, +Inst/-Int – more Instrumental than Integrated, Int/Inst – as Integrated as Instrumental, +Int/-Inst – more Integrated than Instrumental, +Int – essentially Integrated

This model was used to reduce the Boolean functions found, since it eliminates redundancies. This way, regardless of the Dimension, whenever more than one category is assigned to an e-teaching activity, the function resulting from the Veitch-Karnaugh method ($f(AB)$) is applied to assign a single final category to the manifold teaching activities/tasks identified.

To sum up, in terms of data reduction, the methodology described above is firstly to be applied at the e-teaching activity level and, only in a second moment, at the subject and course levels.

2.2.1.2 Students' Perspective

As mentioned above, apart from the teacher's perspective, it is also important to include students in the evaluation process. This is because the results obtained from the latter may serve to confirm (or not) if the student's and the teachers' answers tend to converge, i.e., if both tend to position the manifold e-teaching activities in the same analysis axes defined for each Dimension. Thus, to characterize each of the e-teaching activities developed within a particular subject (Table 2.1), six variables were defined that students should characterize bearing in mind the scale: *not valued*, *slightly valued*, *valued*, *highly valued* (Table 2.9). As depicted in Table 2.9, with the six variables considered, the idea was to determine the value that the student believes was given to each of the poles considered for the three dichotomies defined: 'Conceptual/'Authentic' (C/A), 'Individual/'Social' (I/S) and 'Instrumental/'Integrated' (Int/Inst).

Thus, for each of the students' possible answers, one of the defined poles of each dichotomy (with different weights) was assigned, and in the case of option *Not valued* the aspect under evaluation was not taken into account, and should not, therefore, be considered in the final category (Table 2.9). In other cases, partial results of the evaluation should be dealt with as described in the previous section for the teachers' answers. In other words, the premises described in previous sections for each the three dimensions are valid for the students' answers.

Table 2.9 Variables of the learning, interaction and technology dimensions (student’s perspective)

Evaluation Dimension	Description	Not valued	Slightly valued	Valued	Highly valued
Learning	Developing theoretical and conceptual component	X	-C	C	+C
	Developing practical component (based on solving real problems)	X	-A	A	+A
Interaction	Developing Individual work	X	-I	I	+I
	Developing Collaborative work	X	-S	S	+S
Technology	Providing and sharing information using ICT	X	-Inst	Inst	+Inst
	Accomplishing tasks using ICT	X	-Int	Int	+Int

A – Authentic, C – Conceptual, I – Individual, Inst – Instrumental, Int – Integrated, S – Social

Table 2.10 Determining the final category when partial results do not identify with the subcategories defined for the Learning Dimension

Example	Variable	Not valued	Slightly valued	Valued	Highly valued	Final category
1.	1.1.1.			C		+C/-A
	1.2.2.		-A			
2.	1.1.1.		-C			+A/-C
	1.2.2.			A		
3.	1.1.1.			C		+C
	1.2.2.	X				
4.	1.1.1.	X				+A
	1.2.2.			A		
5.	1.1.1.				+C	+C/-A
	1.2.2.			A		
6.	1.1.1.			C		+A/-C
	1.2.2.				+A	

A – Authentic, C – Conceptual

The Students’ Answers: Data Reduction

The subdivision of each Dimension into a variable for each pole of the three dichotomies (‘Conceptual/Authentic’, ‘Individual/Social’, ‘Instrumental/Integrated’) for the students’ evaluation of the e-teaching activities does not always allow a direct transposition of the students’ answers into one of five categories defined within each dimension (Table 2.9). For example, the lack of a category (when students indicate *Not valued*), together with the maximum value of another (when students indicate *Highly valued*) easily places the student’s answer into the categories +C, +A, +I, +S, +Inst or +Int (Table 2.9). However, the problem arises when the combination of answers given by the students cannot be translated into one of the five categories defined. In order to overcome this constraint, the combination of answers that do not identify with any of the five categories defined for each Dimension were typified and a methodology for data reduction was defined. In Table 2.10 there is an example, where the answers regarding the dichotomy ‘Conceptual/Authentic’ (Learning Dimension) do not directly result in one of the categories in the scale +C, +C/-A, A/C, -C/+A and +A.

Table 2.11 Determining the final category for the learning dimension taking into account the number of students (S)

		Not valued 0	Slightly valued 1	Valued 2	Highly valued 3	Conceptual	Authentic
S1	1.1.			X		2	
	1.2.				X		3
S2	1.1.		X			1	
	1.2.			X			2
S3	1.1.			X		2	
	1.2.				X		3
S4	1.1.			X		2	
	1.2.			X			2
Arithmetic average rounded up to the unit						(2+1+2+2)/4=2	(3+2+3+2)/4=3
Partial categories						C	+A
Final category						+A/-C	

A – Authentic, C – Conceptual

Underlying the correspondence exemplified above, between partial and final categories, is the assumption that it should be given more weight to the most valued category in relation to its opposite pole. In other words, if students’ answer that the ‘Conceptual’ component was *valued* and the ‘Authentic’ component was *slightly valued*, then the ‘Conceptual’ aspect was more valued than the ‘Authentic’ one— ‘+C/-A’ (Table 2.10, example 1). Likewise, if the ‘Conceptual’ component is *valued* and the ‘Authentic’ component was *not valued*, it seems reasonable to consider that the aspect that was essentially crafted through e-teaching activities was the ‘Conceptual’— ‘+C’ (Table 2.10, Example 3.).

Notwithstanding the above, an analysis of the possible combinations of the students’ answers also raised another problem, i.e., even though, in the case of teachers, only one respondent per subject is usually expected, in the students’ case there are not only more respondents but they also may vary in quantity in each subject. Thus, the way found to define a final category, which would more accurately reflect the students’ position as to the value given to each of the six variables, was to assign a numerical value to each of the possible answers and to calculate the arithmetic average of the values rounded up to the unit (Table 2.11), and subsequently the assumptions exemplified in Table 2.10 were applied.

The next section depicts how to apply the principles set above to carry out an evaluation by subject (which includes more than one e-teaching activity) and by course.

2.2.2 SCAI: Overall Evaluation of the Subject/Course

Based on the assumptions that (1) in a given subject usually more than one e-teaching activity is defined, and (2) the idea is to have an overall evaluation of the activities carried out under the several subjects of a course, it seems important to clarify how data reduction should be held in order to find a final category for each of the three

Table 2.12 Determining the final category for the learning dimension taking into account the number of e-teaching activities (A1, A2 ...)

		not assigned 0	-C -A 1	C A 2	+C +A 3	Conceptual	Authentic
A1	Conceptual			X		2	
	Authentic				X		3
A2	Conceptual		X			1	
	Authentic			X			2
A3	Conceptual			X		2	
	Authentic				X		3
Arithmetic average rounded up to the unit						(2+1+2)/3=2	(3+2+3)/3=3
Partial categories						C	+A
Final category						+A/-C	

A – Authentic, C – Conceptual

Dimensions. Because the final results should reflect, as closely as possible, the reality of each subject/course, the option was to assign once more a numerical value to the answers given for each dimension, for each e-teaching activity considered and subsequently calculate the arithmetic the average values, rounded up to unit, and convert these values into the respective categories. Consider, for instance, the following case:

The principles exemplified above (Table 2.12) are equally valid for the Interaction and Technology Dimensions. Still, to get an overall evaluation of the course, and in order to obtain more accurate results, every answer regarding the teaching activities selected for each subject should be included, instead of the averages found per subject, since the use of averages may skew the results. Based on the assumptions clarified above, a way to pattern the results was found, in which the most valued aspects within each of the defined Dimensions are highlighted and the convergence (or not) of the teacher’s and the students’ perspective as to the e-teaching within a subject is verified, as presented below.

2.2.3 SCAI: Representation and Reading Matrices

In order to facilitate the data analysis, the option was to create a visual representation for the results of the evaluation of the e-teaching activities, according to their positioning in the Conceptual/Authentic, Individual/Social and Instrumental/Integrated axes (Fig. 2.4).

As shown in Fig. 2.4, the representation chosen to pattern the results of the evaluation of the e-teaching activities evaluation includes the poles of each of the three dichotomies presented for each Dimension (‘Conceptual/Authentic’, ‘Individual/Social’ and ‘Instrumental/Integrated’), being that the outer ring always corresponds to the presence of the considered aspects in its maximum exponent and the inner ring in its minimum exponent. This way, the most relevant vectors of a

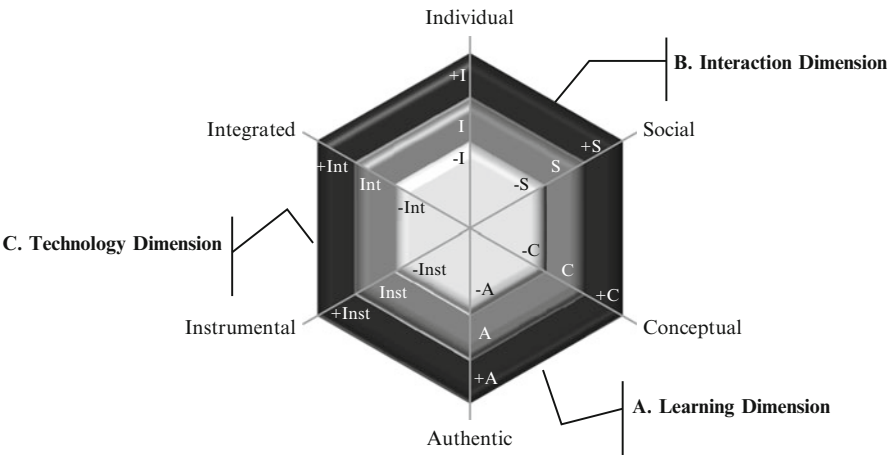


Fig. 2.4 Evaluation dimensions of e-teaching activities: patterns

particular e-teaching activity are identified, as well as the type of relationship that can be established between the six aspects presented. Therefore, taking into account the previous sections, an evaluation matrix was set for the various types of e-teaching activities according to their categorization within the scales established by dimension, as described below.

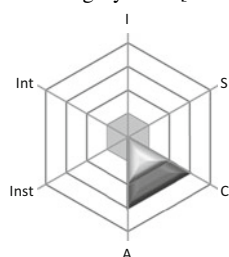
1. Learning Dimension	
– Category: +C [essentially Conceptual]	This type of e-teaching activity: • Lies within the Conceptual Domain, since the applied know-how is not assumed as relevant, giving place to the theoretical description as a way to reorganize prior cognitive structures • Is centered on theoretical representation and description • Leads students to develop their learning based on abstract theoretical concepts, taking into account expected behavior
– Category: +C/–A [more Conceptual than Authentic]	This type of e-teaching activity: • Lies within the Conceptual Domain (conceptual representations), but involves some incursions in the Competences Domain (intellectual operationalization of knowledge); therefore, it implies that students develop some competences in the selection of theoretical solutions to solve problems • Is distinguished mainly by its conceptual, abstract and structuring character as to previous cognitive structures • Leads students to develop their learning by establishing relationships between several theoretical concepts

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1. Learning Dimension

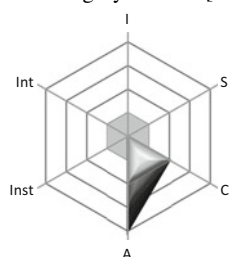
– Category: A/C [as Authentic as Conceptual]



This type of e-teaching activity:

- Positions itself clearly in the Competences Domain (intellectual operationalization of knowledge), in which the practical ('authentic') and theoretical ('conceptual') aspects of learning come together
- Tends to operate on abstract knowledge from the perspective of instrumental know-how, once it implies that the student devises theoretical solutions to realistic problems
- Leads students to develop their learning combining theoretical representations and descriptions with the functional (or practical) aspect of knowledge

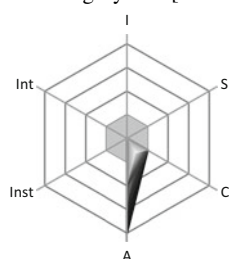
– Category: +A/-C [more Authentic than Conceptual]



This type of e-teaching activity:

- Combines instrumental know-how (Competences Domain) with applied and contextualized know-how (Applied Competences Domain), insofar as it leads the student to build and apply new knowledge in meaningful/significant and authentic contexts
- Tends to confer great autonomy to students as to their own learning, since, besides implying a strong practical component, it also holds the student responsible for the construction of new higher level knowledge of theoretical nature
- Implies that the student has an active role in the learning process and the construction of new knowledge

– Category: +A [essentially Authentic]

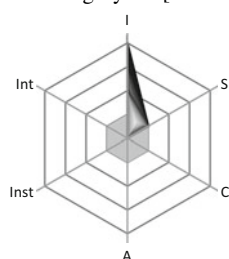


This type of e-teaching activity:

- Leads students to develop transversal and specific competences in realistic contexts (Applied Competences Domain), since it enhances (observable) performance in authentic environments
 - Implies that the teaching/learning theoretical model is not hermetic and is not confined to the period prior to the solution of a problem
 - Leads students to develop their learning through successive iterations to try to solve the initial problem by restructuring and enriching prior cognitive structures
-

2. Interaction Dimension

– Category: +I [essentially Individual]



This type of e-teaching activity:

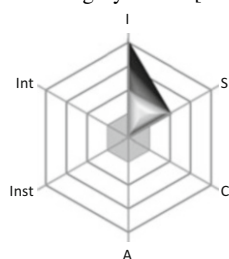
- Is based on individual student reflection, which implies little (or no) interaction with their peers in the construction of new knowledge
 - Leads students to interact with the content by themselves, essentially using ICTs to select and produce information
 - When linked with other type(s) of activity, it leads students to deepen and consolidate new knowledge, readjusting prior cognitive structures to a higher conceptual level
-

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2. Interaction Dimension

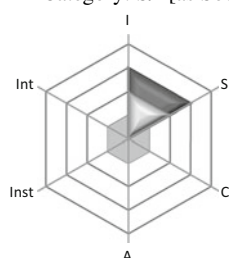
– Category: +I/–S [more Individual than Social]



This type of e-teaching activity:

- Implies that the student primarily interacts with the content, using ICT to select and produce information, but also to share it with the learning community
- Presumes that the teacher assumes some centrality in the learning process, moderating and eventually commenting on information provided by the students or on the students' interaction

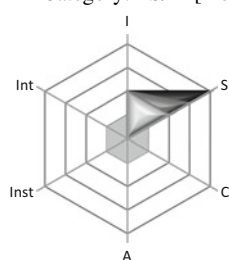
– Category: S/I [as Social and Individual]



This type of e-teaching activity:

- Focuses on the student, not only as a subject but as part of a community in which they operate with their peers and teachers
- Implies the critical construction of new knowledge, grounded on sharing, but, above all, on the discussion of information

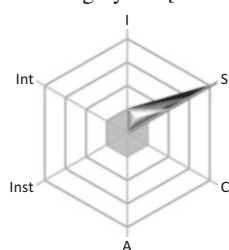
– Category: +S/–I [more Social than Individual]



This type of e-teaching activity:

- Focuses on the student as part of a community
- Implies that the teaching and learning process is assumed as social and dependent on information sharing and discussion between the student and the community—from a restricted (the student's own group) and extended (class) viewpoint

– Category: +S [essentially Social]



This type of e-teaching activity:

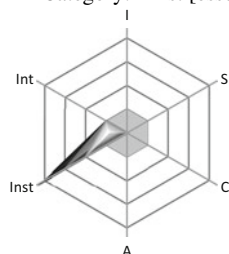
- Implies that the students' individuality is primarily understood in terms of the whole—the group and/or the class
 - Enhances social interaction at the service of collective goals, from a highly collaborative, shared and discussed point of view
-

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3. Technology Dimension

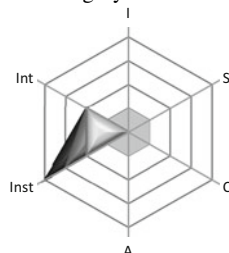
– Category: +Inst [essentially Instrumental]



This type of e-teaching activity:

- Represents the lowest level of technology integration into the curriculum—Entry level
- Implies that ICTs are primarily used to provide information, neither giving learners autonomy, nor allowing them to be critical, as to their learning process, since they are seen as information receivers
- If combined with more student-centered activities, may also serve as introductory, pointing out possible learning paths for students

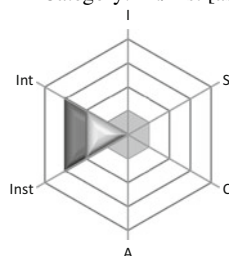
– Category: +Inst/–Int [more Instrumental than Integrated]



This type of e-teaching activity:

- Leads students to use ICTs, mainly from an instrumental point of view, once the selection of these (over others) does not depend on the students' choice (Adoption level)
- Implies little (or no) student autonomy in relation to ICT use, since the way ICTs are supposed to be used, as well as the specific purpose of each technology, were previously defined by the teacher
- Presumes that the technologies defined by the teacher are seen as tools to create learning products

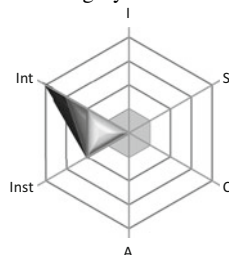
– Category: Int/Inst [as Integrated as Instrumental]



This type of e-teaching activity:

- Presumes that the teacher grants some autonomy to students in relation to how they develop their learning process, which, in terms of technology integration into the curriculum, corresponds to the Adaption level
- Implies that the teacher sets out a range of ICTs that can be used and students are free to select the technology that they consider the most suitable to achieve the pedagogical objectives

– Category: +Int/–Inst [more Integrated than Instrumental]



This type of e-teaching activity:

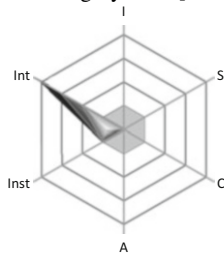
- Overshadows the instrumental role of ICTs, enhancing their integration into the learning process—Immersion level
- Assigns great importance to the technological aspect to achieve the pedagogical objectives
- Gives students great autonomy in the selection and manipulation of ICTs to develop their learning

(continued)

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3. Technology Dimension

– Category: +Int [essentially Integrated]



This type of e-teaching activity:

- Represents the highest level of technology integration into the curriculum—Invention level, since, in its essence, it would not be possible to be fulfilled without using ICT
- Enables students to be critical and have great autonomy in their learning process, since they have to select the most adequate technology and manipulate it to develop their learning

In short, this three-dimension model for the evaluation of e-teaching activities includes teachers and students as agents and is seen as dynamic, once it can be applied to different ICT-based educational contexts and its validity is not directly dependent on the technological development. Next, the methodology adopted to implement the two instruments of e-teaching evaluation, as well as to analyze the data gathered, is going to be depicted.

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