

Chapter 4

The Competency Based Educational Model

4.1 Background

The success of the horizontal and vertical integration of knowledge and resources carried out during the academic year 1995/96 (see Figure 1.4), together with the results of Enhancing Team Performance[®] (ETP) reported in Chapter 3 led to the educational model depicted in Figure 4.1. This model extends the IDP scheme explained before throughout the 5 years of chemical engineering curriculum. External interventions together with ETP modules have been planned for delivery in each year of the program: (see Figure 4.1)

- ♦ to reinforce the initial results obtained with the ETP external intervention in the 1st and 4th year IDP
- ♦ to correct the drawbacks identified in the surveys presented and discussed in the previous chapter

The remainder of this chapter is presented in the format of the paper that has been accepted for publication in the International Journal of Engineering Education with an overall rating of 83/100 (see the reviewed comments in Appendix D).

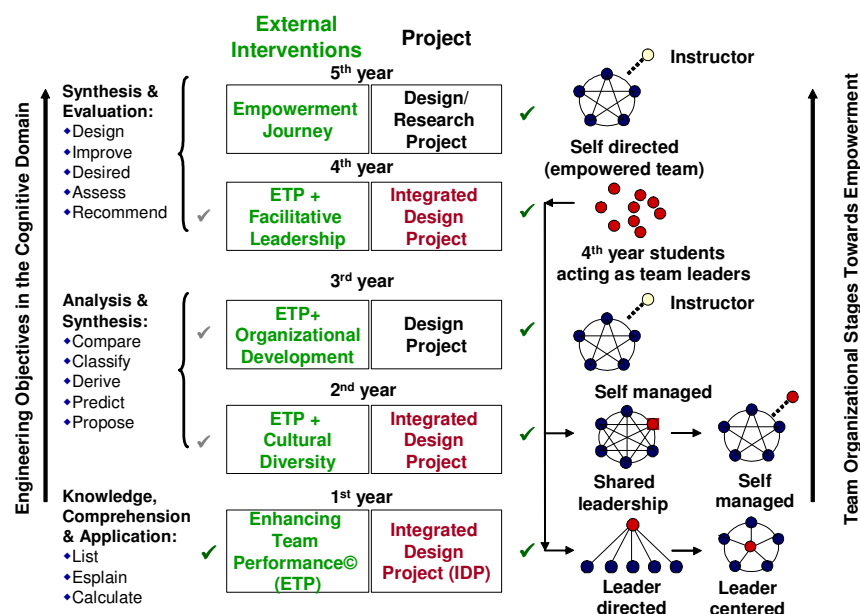


Figure 4.1. The competency based educational model, facilitating the deployment of empowered teams

The fact that the IDP approach started in the 1st year of the ChE program brought forward the opportunity to reinforce the continuous practice, feedback, and positive reinforcement of social competencies throughout the curriculum, and to consider the

possibility of minimizing other less active methodologies such as lecturing and demonstrations [1]. It also posed interesting questions, e.g.:

- ◆ Can social competencies enable or enhance technical and scientific competences?
- ◆ What were the social competencies most relevant to this purpose and for a professionally successful chemical engineering career?
- ◆ Was it possible to disseminate the IDP across the curriculum with a consistent deployment of team organizations leading to the empowerment of individual students and teams?
- ◆ How could we involve instructors and professors in the application of the integrated design project approach?
- ◆ Did we have the necessary knowledge, educational technologies and resources in our own organization to undergo such a drastic change or did we need help from experts outside of the university system?
- ◆ Was it possible to design a model that could incorporate most of these challenging and innovative ideas?

The outcome was a list of hypotheses and requirements for the educational model and an establishment of a partnership with the Dow Chemical Company to obtain expertise in change management as well as human and technical resources.

4.2 The Model

4.2.1 Hypothesis

There is numerous indirect evidence in the study of mankind (i.e. study of prehistory, evolutionary anthropology and psychology), that communication of information and learning among hominids takes place through social development [2]. In fact, both technical and natural selection played a role in the evolution of the Homo sapiens over the past 2,500,000 years. Social learning and social cognition theories provide direct evidence that learning through the consequences of one's actions, which is a tedious and hazardous process of trial and error, can be shortened through social modeling of knowledge and competencies, which has a prominent role in human motivation, thought, and action [3-5]. Also, self efficacy or the beliefs of one's capabilities to organize and execute the courses of action required to manage prospective situations, is key to developing self regulatory strategies, motivation and achievement (in academic settings) [6].

Consequently, the first hypothesis was that social competencies should (not compete with but) enhance the construction of scientific knowledge and the acquisition of technical competence even over the short time scale of the duration of undergraduate education, if consistently and experimentally worked out all the way through the curriculum. This could be accomplished smoothly with IDPs carried out with students working in teams, as indicated by experiences of the research associates [7-10]. This hypothesis has been already stated in Chapter 3, where preliminary analysis of its validity, based on the results of the surveys, has been presented.

The second hypothesis was that empowerment of individual students and teams could be accomplished simultaneously within the social learning environment, if the model to be implemented would consider the appropriate evolution of team organizational stages, initially from leader directed and leader centered scheme in the 1st year to a self directed organization just before graduation at the 5th year of studies[†]. Table 4.1[#] describes these team organizations in terms of responsibilities and activities of team members that have been adopted at the ETSEQ and which has been inspired by the team based organizations considered at Dow. The 19 activities listed in Table 4.1 are exhaustive and fit very well those typically needed to carry out the design projects at the ETSEQ. Within the self directed team organization, deployed at the 3rd and 5th years, respectively, students become progressively empowered, since they are given the right to make decisions and take actions on their own without previous approval by instructors. This authority to act encourages students to further assume responsibility for their actions, which also results in an improvement of the model.

The third hypothesis was that the progressive deployment of the IDP approach, with team organizations matching student skills and needs (see Table 4.1), should facilitate the adoption of a competency based educational model. In the context of the current study, a competency is a combination of tangible (skills and knowledge) and intangible (social role, self concept, traits and motives) underlying characteristics of an individual that is causally related to criterion referenced effective and/or superior performance in a job situation [11].

The fourth and last hypothesis was that faculty and the school system would accept that the educational system did not possess the know-how to manage the cultural change [12]. Such a shift towards the competency based educational model referred to in the previous two hypotheses would require substantial outside expertise and subsequent willingness to partner with a chemical manufacturer, such as the Dow Chemical Company. The fact that the Dow was willing to establish a partnership in 1997 (see Figure 1.5) and to facilitate this process by providing expertise and technologies, such as workshops, on:

- ♦ team development
- ♦ knowledge/awareness of critical competencies, and
- ♦ methodologies to manage change

was assumed to be a sufficient incentive to facilitate and sustain the required change. The workshop materials should support the development of competencies and should be taught as compulsory external interventions initially by consultants and human resource personnel from the Dow Chemical Company and later on by subsequently trained faculty. An external intervention is an extra-curriculum activity which is carried out at specially allocated hours in the academic timetable.

[†] The surveys in Chapter 3 indicate that this team evolution is needed

[#] All Tables are included at the end of the chapter

4.2.2 Framework

The four hypotheses stated in the previous subsection led to the educational model depicted schematically in Figure 4.1. The model framework spans dynamically over the 5 years of studies in two domains:

- ♦ in the cognitive domain pertaining to science and engineering contents and processes, according to Bloom's taxonomy [13]
- ♦ and over different team organization stages towards empowerment

In the context of current work, Bloom's taxonomy has to be understood as expanding over engineering objectives, i.e. beyond the integrated set of the formal operations that any adult, educated person performs in real life. The ticks in Figure 4.1 indicate the current level of implementation, from fully operational (bold tick), under field testing (grey) to pending (no ticks).

The model is based on integrated projects in the 1st, 2nd and 4th years and in projects carried out by self directed teams in the 3rd and 5th years, to assure the right setup and environment for the development of social and professional competencies. Activities carried out during project development and projects closing, which are listed in Table 4.1, require that students clearly identify project clients (mainly activities 1 and 4 in Table 4.1). Thus, client orientation is central in the competency structure adopted, with the rest of 9 competencies emerging as correlative concentric circles characterized by need to act to attain client satisfaction. This is schematized in Figure 4.2 in terms of competencies, with the required individual, organizational and institutional transformations identified by the increasingly lighter levels of grey. The inner circles of competencies in Figure 4.2 pertain more to individuals working in teams and imply the transformation of both individuals (four inner circles with darker grey) and of the organization (three intermediate grey circles). The two outer circles of competencies (lighter grey) reflect more the role of individuals at the institutional level, whereby student empowerment can develop more effectively and be more valued, and all changes institutionalized. Clearly, client orientation (black central target in Figure 4.2) first requires that any individual should adapt to client moves, i.e. be versatile, and subsequently find creative solutions to these new challenges, i.e. be entrepreneurial and innovative. This in turn calls for system thinking, moving in the structure depicted in Figure 4.2, which is self explanatory. The summary of corresponding transformations is depicted in Figure 2.6.

Since social competencies have to grow from a client orientation perspective and be developed by team members simultaneously and in conjunction with regular academic activities, such as lectures, laboratories, seminars, etc., the educational, competency and transformation models respectively shown in Figures 4.1, 4.2 and 2.6 are supported by the set of five hands on, external interventions stated in Figure 4.1. These interventions have been conceived and designed to be delivered by professionals in the field and/or faculty previously trained in the respective topics and on the educational technologies used. The topics of the five external interventions, briefly described in Table 4.2, match both the team organizational stages planned for

each of the five years of studies and the client oriented competency model of Figure 4.2.

The following subsection presents and discusses the ten social competencies that have been adopted at the ETSEQ, which are summarized in the concentric model depicted in Figure 4.2.



Figure 4.2. Concentric structure of competencies aimed at client orientation.

4.2.3 Competencies and Rationale

Table 4.3 lists the ten key competencies, together with their operational definitions, that have been identified at the ETSEQ, and that should also be enablers for technical competence as stated in the hypothesis subsection 4.2.1. The current selection is consistent with the extensive research reported on the trends and changes that influence the economic and social environment in which industry is operating [14-17] and with the experience gained with the implementation and continuous refining of the 1st and 4th year IDP at the ETSEQ [10,18]. The Dow Chemical Company and other chemical corporations have also identified these or equivalent competencies as critical components in their recruiting process. Finally, the set of competencies listed in Table 4.3 is in accordance with the opinion of other educators and policy-maker institutions [19-21].

The know-how developed by The Dow Chemical Company on planned organizational change [22] suggests that the set of competencies of Table 4.3 constitutes a valid and consistent starting point to implement an effective and

sustainable organizational change. Figure 4.2 illustrates the dynamics of this organizational transformation when it is unambiguously aimed at achieving client satisfaction through client orientation. Every significant move of client needs stated in Figure 2.6 prompts three waves of transformation involving the individual, organizational and institutional level. Research supports the assumption that the only relevant component that should be molded (changed) in an organization is individual habits, i.e. the attitudes and perspectives of each individual [22, 23]. Change always starts at the individual level. The change of individuals brings about organizational transformation. Once organizational transformation has taken place, the new way of working has to be institutionalized in order to ensure that the changes are sustained and that no significant erosion takes place. Erosion would be detrimental, as the organization would gradually slide back to the status quo or the starting point of the change initiative.

Table 4.3 summarizes the operational definitions of the competencies adopted at the ETSEQ. Figure 4.2 arranges these competencies in “need to do activities” consistent with client orientation. The central competence of Figure 4.2 and the first in Table 4.3 is client orientation, the one that triggers individual transformation. An individual within a client serving organization must be able to perceive a shift in client needs and to adapt accordingly. Productive performance during change requires versatility, since the individuals are likely to be catapulted out of their comfort zone. To cope with inflicted stress, a high degree of versatility is needed, as one has to adapt by changing one’s views, perspectives, assumptions and behaviors. The next competency under scrutiny is entrepreneurship and innovation. Versatility has brought about capacity to adapt to change. It now has to be followed up with creative ideas to respond to the new challenges posed by the client directly or indirectly through the organization. On an institutional level, entrepreneurship will aid to translate creative ideas into tangible business opportunities. The next layer of the concentric model in Figure 4.2 is system thinking. Business opportunities have to be put into perspective, i.e. the whole system of individual and organizational interactions has to be reconsidered. Critical reflection of one’s position in relation to the new system will consequently trigger new learning. It is most likely that a number of competencies will become obsolete and will have to be replaced by new ones. The skill transformation calls for the responsible and active learner’s competency or else no change will happen. The issue of life long learning emerges clearly on the business horizon [24]. This notion is quite a challenge in itself, as it conflicts with traditional way of looking at education. The perception that after graduation there is only work to be done is changing rapidly. This last circle of individual transformation, responsible and active learners, leads to the first sphere of organizational transformation, which is facilitative leadership. Facilitative leadership is the pivotal point, whereby the impact from individual domain will be translated into collective domain, a process which is only possible through leadership. At this point, the individuals affected have completed the personal transformation cycle and are now skilled and ready to spark and facilitate changes in others. The 4th year students acting as leaders and facilitators in 1st and 2nd year teams assume this pivotal role in the current model, as shown in Figure 4.1.

Organizational transformation initially starts within the smallest nucleus of the organization, which typically happens to be a team or a group. The team reinforces the changes via cooperation and the collective analyses of client needs. This is reflected in the teamwork and cooperation competency. When several teams or small groups interact, the level of complexity increases exponentially [25]. This calls for a higher competency level of human interaction. As change grows, the likelihood of miss communication and errors by default is usual. A good skill set of human interaction minimizes these side effects of change. When individuals communicate and interact well with each other, challenges and barriers become opportunities for everybody in the organization, and the number and size of conflicts decreases. This concludes the intermediate three circles of competencies involved in the transformation of the organization, as shown in Figure 4.2.

Now that the individual and organization levels are mutually aligned to cope with the new scenario of client needs, the changes attained have to be institutionalized. This happens when the individuals acquire the two outer competencies in Figure 4.2: organizational development and performance, and organizational leadership. In our educational organization, work and process management competencies have both been integrated into the competency organizational development and performance, which characterizes individuals that can plan, implement, and evaluate any action within the organization or in smaller empowered teams, as stated in Table 4.3. This ultimately implies continuously updating and disseminating the relevant procedures and system documentation across the organization. In addition, the interaction across the organization has to be reflected in business and work processes that are aimed at satisfying client needs [26]. The last competency of organizational leadership, both in Figure 4.2 and Table 4.3, is characteristic of senior management, i.e. in our case senior students. It ensures that the transformation is complete and yields the expected results. An appropriate evaluation cycle to validate the degree of transformation implied in Figure 4.2 in relation to client satisfaction has to be initiated.

4.3 The Key Competency Model Components

4.3.1 Integrative and Experiential

The experiential learning approach applied at the ETSEQ, which is illustrated in Figure 4.1 and described in sub section 4.2, is IDP. It is based on combination of project based learning [27] and cooperative learning methodologies [28]. Both methodologies are well suited for engineering education, because project management and teamwork are key enablers for any design activity, which is the essence or engineering [29]. A detailed description of the approach as applied to the 1st year of the ChE program at the ETSEQ has been presented elsewhere [10,18]. This subsection focuses on those characteristics of the approach that generate the dynamic concentric transformation wave of Figure 2.6, which is depicted in grey levels in Figure 4.2.

Since client satisfaction plays a pivotal role in, it became apparent from the beginning that clients should be real and accessible to students. Professors responsible for the different courses that participate in the IDP act as clients and are, consequently, the driving force for the transformations of Figures 2.6. The IDP is not a stand alone course. It is a teaching and learning approach that is horizontally implemented in the regular class hours of the existing courses. At the beginning of each semester, professors that teach courses in the first three years of the ChE program select a set of engineering and project oriented instructional objectives in the cognitive domain from their corresponding syllabuses and hand them out to the project teams. The objective is that students achieve the engineering objectives by themselves through the project and, consequently, begin to take on responsibility for their own learning. The level of these objectives varies depending on the year in the ChE program according to Bloom's taxonomy (knowledge, comprehension, application, analysis, synthesis, and evaluation) [13]. While it is expected that first-year students achieve objectives up to the application level in relation to engineering practice, for example process design, the 4th year students should be able to formulate design problems, evaluate the learning approach itself, etc., i.e. reach up the highest level of Bloom's taxonomy in relation to engineering practice. The increase of complexity in the level of instructional engineering objectives over the ChE program is shown on the left side of Figure 4.1. Together with the set of objectives, instructors allocate 25% of their regular class hours to project design and team work. As a result, students work an average of 5 hours per week on the design project.

As in any real world experience, students enrolled in the first three years of the ChE program soon realize that each professor/client is a universe by itself. Some professors know very well in advance which results they want to get from a particular project, while others keep constantly changing their instructional objectives, even when the project is already approaching the closing phase. This dynamic forces the students to put in place effective communication processes with clients, i.e. to develop the client orientation competency, consistently demanded by chemical manufacturers [14]. It also fosters preventive thinking and triggers the preparation of contingency plans.

The model in Figure 4.2 also implies a learning/working environment that facilitates the development of competencies by daily hands on practice, with coaching support in terms of positive reinforcement and feedback. It is very difficult, if not impossible, to develop a competency up to a professional level only by attending a traditional single discipline course. Hence the need to deploy extensively the integrated design project structure over the ChE program. It is noteworthy to realize that this constant simulation of engineering practice makes the competency based educational model also an excellent approach to cope with criterion 4 of the ABET 2000 Criteria Standard: Professional Component [20].

This gradual growth of competencies is exemplified by the systematic development of project teams throughout the program, as illustrated on the right side of Figure 4.1. The experience accumulated during the last decade by The Dow Chemical Company in the development of empowered teams recommends a progressive

transition from leader directed student teams in the 1st semester of the 1st year to self directed teams in the 3rd year of the ChE program. Each of the stages in this empowerment journey entails that students are ready to take on additional responsibility for managing the IDP approach and, eventually, for their own learning. Table 4.1 shows in detail which specific activities are taken on by students as they progress through the different stages towards an empowered team. This team development structure represents an organizational transformation that has to be necessarily supported by the appropriate individual transformation. For example, at the heart of the shift from the traditional single discipline lecturing format to a team based learning approach lies the need that students realize, and hopefully begin to assume personal responsibility and voluntary commitment to their own learning.

One key success factor in this empowerment journey is team leadership. Leadership is a critical component for the success of any team [18]. In addition, any effective organizational transformation requires that facilitative leadership competencies are in place, as indicated in Figure 4.2. Consequently, it was projected that 4th year students, who had already endured a deep individual transformation, would act as facilitative leaders of project teams formed either by 1st year or 2nd year students. The participation of 4th year students as facilitative leaders of 1st and 2nd year project teams is in accordance with social learning theory [4] and self directed change research findings [30]. The latter research claims that people learn interpersonal skills from behavior role modeling. This social modeling of knowledge and competencies can be best realized in teams of peers, because of the prominent role that human motivation, thought and action play in this process. Individuals are open to develop a new competency only when they realize that it is important to do their jobs well, because there exists a discrepancy between the current and the ideal level of competence. Therefore, 4th year students act as role models for 1st and 2nd year students and trigger their motivation to work hard to develop the required competencies. Furthermore, the 4th year students are in a better position than instructors to create a socially “safe” and supportive environment in which to learn, experiment with, and practice new learning methodologies and behaviors. This is a basic feature of the model, since self directed behavior change research strongly suggest that students need to experience high psychological safety to assimilate effectively the integrated design project approach and not to perceive it as a threat. In addition, 1st and 2nd year students see 4th year students as fellows who have already passed successfully through the project experience and who can provide valuable support and coaching and increase the chances of success [31]. The leadership role responsibilities also vary depending on the development stage of the team, as shown in Table 4.1. Finally, it is expected that all 3rd year project teams will reach the self directed stage, where all activities related to the management of the integrated design project approach are carried out by 3rd year students exclusively. This outcome should emerge from the experience of the earlier team organization stages shown in Figure 4.1 and as a result of the specific courses and external interventions expressly designed and delivered with this purpose in mind.

4.3.2 Specific Courses and Interventions

Table 4.2 describes the external interventions that support the educational model and the competency structure presented in Figures 4.1 and 4.2, respectively. Table 4.4 extends this information by including the elective and compulsory courses that sustain the whole system from within. As it has been explained in the previous subsection 4.3.1, teams are the basic organizational unit where students learn and develop social competencies. Therefore, the development of the teamwork and cooperation competency, even though located at the concentric circle number 7 of client orientation in Figure 4.2, is a priority and had to be strategically planned and supported by appropriate training interventions from the 1st year of studies.

The Enhancing Team Performance[®] (ETP) methodology developed by The TRACOM Group [32] was selected in late 1998 and fully implemented among professors and 1st year students in 2000 as external intervention to support teamwork and cooperation in the ChE program (see chapter 2.5).

The 1st year students are currently trained in the ETP modules:

- ♦ Fundamentals
- ♦ Change
- ♦ Team Operating Procedures
- ♦ New Member Integration
- ♦ Recognition/Reward (see table 4.4)

Students start working in project teams beginning the 2nd week of the 1st semester of their studies when they are acquainted with critical components, which contribute to optimum team performance. The Fundamentals module conveys, in a workshop format, that leadership, relationships and methods are critical components of optimum team performance. Each of these components contributes the following 3 characteristics:

- ♦ common purpose, team capabilities and change for leadership
- ♦ team norms, communication/conflict and recognition/reward for relationships
- ♦ team operating procedures, new member integration and evaluations for methods

The roles of team members, team managers and organization, together with the balances for leadership (guidance vs. freedom), relationships (support vs. candor), and methods (consistency vs. flexibility) are then analyzed. After that the phases of team formation, solidification and optimum performance are introduced. Finally, the cementing of the 3 components, 9 characteristics and balances by trust results in focus on the leadership component, interdependence in the relationships, and innovation in the methods. The module on Fundamentals increases the ability of students to adapt to the new environment and to decrease dropout. The module Change deals with the nature of change, how humans react to change, and how change impacts leadership, relationships and methods in a team. The process of change management is also analyzed, embedding the following stages:

- ◆ problem/opportunity recognition
- ◆ agreement on course of action
- ◆ action
- ◆ evaluation

The leader and member roles are examined. The Change module stresses the importance of being change receptive. It is imparted in a practical manner, since it is applied to manage change that 1st year students undergo. The following ETP© modules: Team Operating Procedures, New Member Integration and Recognition/Reward respectively, expose 1st year students to procedures needed for successful problem solving activities and team meetings; excluding or integrating members; establishing a reward system to recognize accomplishments. This 1st year external training intervention is fully implemented as indicated in Figure 4.1.

2nd year project teams start within a shared leadership team organization in the 1st semester, which evolves into a self directed stage during the 2nd semester, according to the model in Figure 4.1. This means that the responsibilities of the 4th year students leading teams in the 2nd year of IDP shift with respect to those at 1st year in line with Table 4.1. The ETP© Common Purpose module helps 2nd year students to establish their team vision, mission, objectives and action plans. It also helps differentiating commitment and compliance. The 2nd ETP© module Team Norms reinforces the need for norms (initially ground rules) and values within a framework of behavioral expectations. Students become fully aware that they belong to an educational organization that has the purpose to operate as a whole in a similar way and that has values. The team norms and values have to align with those adopted by the school:

- 1) We are a team where people are the most important part;
- 2) A commitment to serve the community beyond the expectations of stakeholders;
- 3) Efficiency, reliability and responsibility;
- 4) Excellence in the generation and dissemination of knowledge;
- 5) Entrepreneurship, initiative, dynamism, versatility and adaptability.

In addition to these two ETP© modules on common purpose and norms, which have been already field tested and are fully operational, the external intervention Cultural Diversity (see Table 4.2) is also in the process to be delivered to 2nd year students as a workshop. The purpose of Cultural Diversity is to gain insight in the relationship between cultural patterns and behaviors and actions. The workshop is based on the resource Managing Across Cultures from the Dow Chemical Company. The field testing status is the reason why the 2nd year external interventions are represented by grey color of tick mark in Figure 4.1. Finally, the non compulsory course Communication Techniques for Chemical Engineers is an additional resource that has been available since the early years of implementation of the ChE program to help students in their oral, written and multimedia presentation skills. Students are also introduced to the process of improvisation.

3rd year project teams reach the self directed organizational stage. As shown in Figure 4.1, 3rd year students are on their own to work as a team after having received 2 years of facilitation support from 4th year students. With this critical team organizational change in mind, 2 types of external interventions have been selected. The 1st one incorporates the modules of ETP© that deal with the remaining three modules: Team Capabilities, Communication/Conflict and Evaluation. The second external intervention Organizational Development is complementary to the above and focuses on client orientation and system thinking (see Table 4.2). Together with organizational design, strategy development and implementation, and business processes, this external intervention also introduces students to different management models, such as the EFQM Excellence Model, the ISO 9001:2000 standard, and the ABET 2000 Engineering Criteria so that they can evaluate the competency based educational model and identify their strengths and areas of improvement. The ETP© Team Capabilities module teaches to capitalize on team skills, knowledge, experience and individual differences. The Communication/Conflict module analyses the communication loop, the causes of team tension and conflict, and the standard responses to conflict. The Evaluation module is critical in the concentric competency model of Figure 4.2, since it comprises the three levels of evaluation: customer satisfaction, team performance and individual member performance. It is not surprising that the above three ETP© modules are highly valued by the 3rd year students as the latter have to overcome the organizational barrier of self management as a team. These three ETP© modules have been successfully tested by professors and students and are currently in the field testing stage by the 3rd year students of the ChE program.

The ChE program offers to 4th year students, which are the agents that retro feed into the system the social learning component by acting as leaders and facilitators of 1st and 2nd year teams (see Figure 4.1), two yearly compulsory courses in project management: Project Management (PM) and Project Management in Practice (PMP). The PM course introduces 4th year students to the basic managerial methodologies and competencies, such as project management and facilitative leadership [18]. The PMP course accounts for the hours that they dedicate to lead and facilitate 1st and 2nd year teams. Since the PM course and the previous experiences accumulated by 4th year students in previous ChE classes do not assure the smooth transition to the PMP course, two types of training interventions are in the process of being field tested. The first is the complete set of ETP© modules offered as a ChE elective with the purpose of revisiting the critical components and characteristics of an optimum performing team. The fact that students are credited for this elective course makes this offer very attractive. The second is the external compulsory intervention Facilitative Leadership described in Table 4.2 and which is currently at a pre testing field stage.

Finally, the 5th year external intervention Global Empowerment has been adopted to cope with the outer competencies in the concentric model of Figure 4.2. These management competencies should enable students to develop, implement and improve continuously the management system of any organization. If students have to close their learning process cycle, it is required that they reflect both on the results achieved through the competency based educational model and on the way that

these have been reached. In order to reflect on the latter, it is essential that students can understand the management system of the educational model itself. Only in this way, they will be ready to help assess and review the educational model and complete their empowerment journey, sharing the ownership of the School with faculty and staff. The Global Empowerment course has been designed from the materials of the workshop on Global Empowerment Assessment by the Dow Chemical Company.

4.3.3 Assessment Process

The assessment process has only started at the 1st-4th and 2nd-4th integrated design project (IDP) stages of the model. The initial approach focuses both on “what” work is done and on “how” that work is done by individual students acting in the team organizations depicted in Figure 4.1 and Table 4.2, and in accordance with the practices of Performance Management [33]. The “what” element encompasses the engineering deliverables typical of design projects, which are handed out in the format of a final report and of a public presentation of results to clients, sponsors and social stakeholders in a poster session. The more technically oriented components of the “what” element of the assessment process are evaluated during the closeout phases of the project, one per semester. This evaluation gives rise to a score or mark that is common to and shared by all team members. The “how” element of the assessment encompasses the development and use of the competencies shown in Figure 4.2 and Table 4.3. This element is continuously evaluated through all of the phases of the project, from planning to closeout, resulting in individual student appraisal. Table 4.5 describes in detail how both elements, the “what” and the “how”, are evaluated for the specific case of 1st year students participating in the 1st and 4th year IDP. It can be seen that in this case both elements have the same weight, indicating that achieving good technical deliverables as a team is as important as the path taken to accomplish the task.

The use and development of competencies have been so far evaluated for the 1st year students by applying the procedure sketched in Figure 4.3. This procedure is largely inspired on the findings of self directed behavioral change research [30]. In essence, it states that the more the students control their change process, from the initial goal setting stage to the point where the progress toward the goal is evaluated, the higher the likelihood that they will eventually take on personal responsibility and voluntary commitment to change and to achieve their change goals. Again, it has to be emphasized that self efficacy or the beliefs in one’s capabilities to organize and execute courses of action required to manage prospective situations, is key to developing self regulatory strategies, motivation and achievement in the academic setting [6]. Therefore, the IDP provides a convenient social environment to learn and develop competencies.

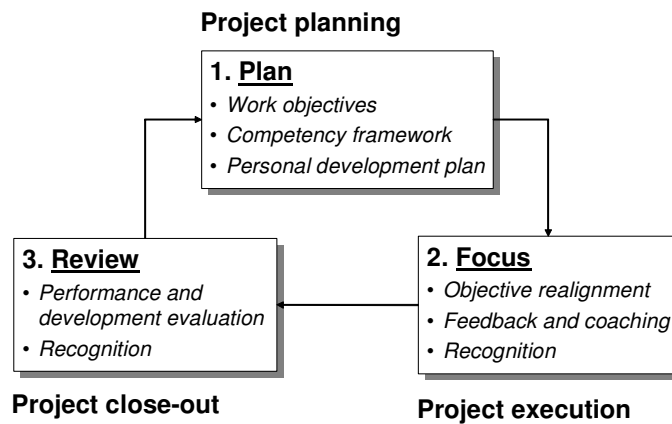


Figure 4.3. Evaluation procedure for the use and development of competencies in the integrated design projects

During the planning phase of the project, team leaders facilitate the assignment of work objectives to team members and help them to understand the competencies that will support the achievement of the work objectives. In doing so, team leaders make use of a competency form, in the format of a 10+ pages long questionnaire available upon request from the authors, that collects definitions and behavioral indicators clustered in different levels of competency mastery for all the competencies described in Table 4.3. This competency form is largely based on generic competency dictionaries such as that proposed by Spencer and Spencer [34]. Students are trained to use the competency form and the overall assessment process right at the beginning of the integrated project. This competency form constitutes a conceptual framework for students to analyze their behaviors and become aware of the deviations that may exist between one's current level of competency and the desired level. Finally, the competency form facilitates the provision of feedback and recognition by team managers, team members, and professors during the execution of the project.

During the closeout of the project, each team member holds a meeting with the team leader to reach a consensus on competency evaluation (development and use). Team members - 1st year students - bring to this meeting a self assessment based on the competency form. This self assessment constitutes the basis for discussion with the team leader who, in turn, uses all data on team members recorded during the planning and execution phases of the project. In this meeting, the team leader and the team member work to reach consensus on the self assessment, i.e. on the actual level of competency achieved. They also discuss the developmental goals that are reasonable to consider for the next stage of studies. If consensus is not reached, a professor of the PDP course (sponsor) mediates the search for a compromise.

4.4 Deployment and Preliminary Evaluation of the Model

The ETSEQ had to undergo the concentric transformation waves shown in Figure 4.2. An organizational change initiative like this one poses a colossal challenge that requires a large amount of effort and long term planning. In addition, if this change has to be implemented at a research oriented university, where the recognition and reward processes are not fully aligned to foster improvements in teaching, the endeavor becomes even more challenging [35]. Ultimately, the whole university system should also undergo the above mentioned transformation waves. In spite of these unfavorable conditions, the ETSEQ has smoothly progressed along individual and organizational transformation waves over the past ten years. Figure 1.5 highlights the milestones of the competency based education model implementation process at the ETSEQ. Overall, there are two key success enablers that have driven, facilitated and sustained such a change.

The first key enabler being the strong determination and leadership of a group of professors, circa 25% of the total faculty, actively involved in promoting effective teaching methodologies [9]. The second key success enabler being the ETSEQ/Dow Chemical Company partnership that was established in 1997. As a result of this partnership the Dow Chemical Company has provided professional change management consultants and methodologies to facilitate the organizational change needed at the ETSEQ to deploy effectively the competency based educational model. A series of workshops were organized in order to create a common vision for the ETSEQ, develop key elements to reach that vision, establish change readiness, and develop change leadership. Most of the ETSEQ professors and staff participated in these workshops and realized how much of a change the competency based education model would mean to the current way of teaching. The Dow Chemical Company has also provided expertise on team management and team development, and has facilitated the access to several learning resources. For example, the ETSEQ obtained from the Dow Chemical Company licensing use of Enhancing Team Performance[®] workshop materials [32] and other support for external interventions (extra-curriculum activities).

The IDP and the rest of project based cooperative learning approaches were institutionalized by the ETSEQ dean following the approval by the governing council at the end of the 2000/01 academic year. The deployment of the approach over the first 4 years of the ChE program has just been completed in this year 2005 due to resistances to change encountered at the 2nd year of the program. The approach followed to overcome this difficulty has been to involve professors into the new system rather than impose the new system on them. As a result, there is an expectation that transformation undergone by the ETSEQ, which follows the model in Figure 4.2, will be more enduring than if started as an institutional initiative. The current approach of client oriented, breakthrough changes is more likely to generate commitment and a sense of ownership among faculty, students and staff.

The backbone of the model in terms of the project oriented cooperative learning approach (central right column in Figure 4.1) is currently (year 2005) in place and

The Competency Based Educational Model

operational. The deployment of external training interventions (left column in Figure 4.1) is complete in 1st year and is at the field testing stage in 2nd, 3rd and 4th years. The workshop Enhancing Team Performance©, that has been adopted to train both students and professors, has enhanced the overall acceptance of the educational model. It also accelerates the formation of teams and the perception by students that working in teams is of advantage in engineering practice. Breaking this barrier or cultural shift from individual to teamwork has in turn facilitated the social modeling of knowledge and competencies that are inherent in the proposed model.

Global Empowerment is the only external intervention that is currently pending. According to Figure 4.1 and Table 4.2, this intervention, which is planned for the last year of studies and has a workshop format, should enable pre graduating students to implement, evaluate and improve continuously the management system of an organization. To reinforce the following two competencies, Organizational Development and Performance and Organizational Leadership (see Table 4.3 and the two outer circles in Figure 4.2), Global Empowerment should encompass in the workshop allocated (see Table 4.4), several mini projects carried out by teams of 5th year students to self assess the organization. These mini projects should be designed so that they can be carried out in close collaboration with the 4th year students acting as leaders and facilitators of IDP. Also, they should emerge from within the EFQM's cyclic RADAR methodology [36], which involves the phases of Results, Approach, Development, Assessment and Review, shown in Figure 4.4.

At the core and sustaining the RADAR cycle are the needs to INTEGRATE all enabling agents (leadership and processes affecting people, policies and strategies, alliances and resources) and operational processes, and to MEASURE all results. The enabling agents are well taken into account by the model itself and by the partnership with the Dow Chemical Company. The components of RADAR that are totally or partially missing currently are those related to MEASURE (perception measures and indicators), both in the assessment and review, and in the results step of Figure 4.4.

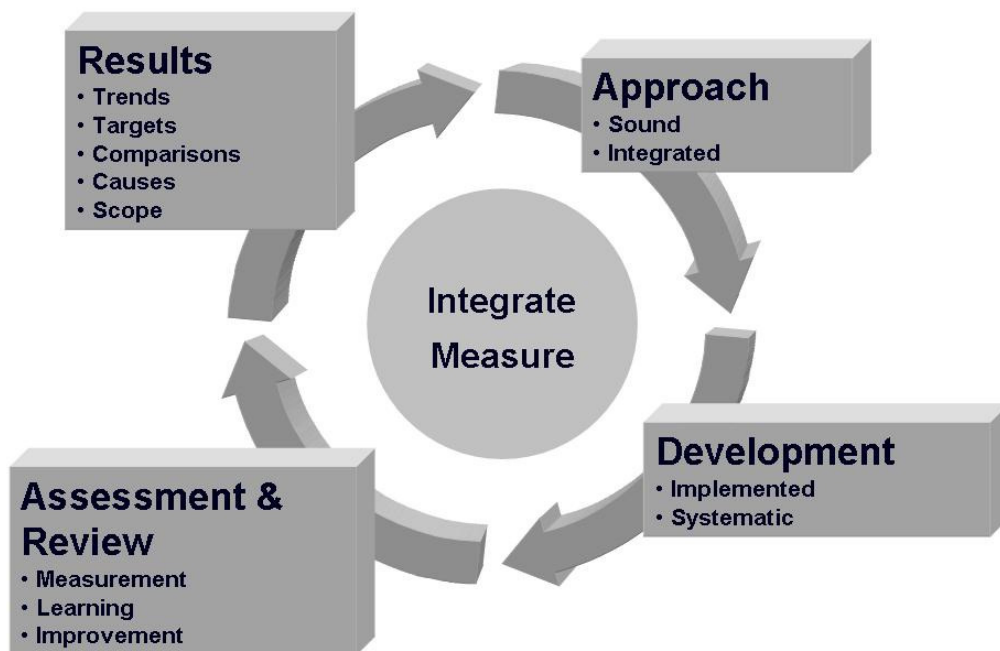


Figure 4.4. The self assessment RADAR cycle of the European Foundation for Quality Management

The assessment and review together with the analysis of results of the competency based educational model that 5th year students will carry out, should close their own learning process loop and contribute to the institutional transformation wave of Figure 4.2, which is a key area of improvement at the ETSEQ itself. Many procedures have been developed and documented throughout the years and the educational model has been continuously improved. However, there is not an accepted process management system along with associated process indicators in place. Such a system be used to assess comprehensively and quantitatively the model and, ultimately, identify, prioritize, plan and implement improvements. Probably, it is necessary that the ETSEQ goes first through this institutional transformation wave, facilitated by the ABET and other regional and national accreditation processes, before the self assessment related competencies can be developed by senior students. The successful implementation of the last intervention on empowerment is a key factor for the ongoing completion of the last two steps Assessment & Review and Results of the RADAR cycle (Figure 4.4) and for the continuous improvement of the current educational model.

The fact that most measures of the assessment currently available are of a qualitative nature does not impede to clearly perceive that classes are overwhelmingly attended, that drop out has decreased to background noise levels, that more professors act as facilitators in the classroom, and that teaching methods are more active and student centered every day. Since the proposed educational system is client oriented, it is worth stating the opinion of our industrial partner. The

Dow Chemical Company has felt the positive impact of the competency based educational model of the ETSEQ when selecting chemical engineering students for internships or graduates for new jobs. The first indicator that shows positive tendency is the number of 5th year students who carry out their industrial internship at Dow Chemical Ibérica. Placements of ETSEQ students as a percentage of total student internships has increased tenfold, from 5-7% in the late 90's to a current average of 50%. The Dow tutors highlight the fact that ETSEQ students are not only technically well prepared, but also are highly valued for their ability to overcome difficulties by searching effectively alternative solutions with initiative and teamwork. Another indicator that reinforces this positive trend is the percentage of ETSEQ chemical engineers hired annually by the Dow, which has increased by a factor of nearly three over the same period. It should be noted that the Dow follows a competency based interview scheme for recruiting purposes. The scorings of ETSEQ chemical engineers showed that:

- ♦ they possess the technical knowledge required for the job
- ♦ they are open to new challenges
- ♦ they are willing to stretch goals through effective communication, teamwork and joint development

These preliminary but qualitatively conclusive results (evidence) show that the competency model works and that it has the desired effects on student education. These trends are an encouraging early sign that the four hypotheses stated in subsection 4.2.1 are consistent with the scope of the current endeavor. It remains to measure how much this effect is tangible in every competency and to define improvement actions. In doing so, each competency will be divided into measurable components or characteristics. For example, client orientation can be broken down and measured as:

- ♦ gives a quick and adequate response to (responds to demands, questions, complaints and requests made by) clients
- ♦ shares information (keeps communication open) with clients
- ♦ finds solutions to and reaches consensus about (commits to solving) client's problems
- ♦ involves others (works) to improve service
- ♦ adds value (economical, environmental, health and safety, etc.) to clients beyond expectations

The process of defining indicators for every competency is the next step in the assessment and review step that 5th year students will carry out according to the RADAR methodology depicted in Figure 4.4.

4.5 Final Remarks

The initiative of a team of professors committed to active teaching methodologies, together with the pressures from ABET and other European accreditation boards, led to the adoption of a competency based educational model at the ETSEQ. To support the change from a conventional educational organization to a competency based system with empowered students, a partnership with Dow Chemical Ibérica was

established. This partnership facilitated the implementation of a project based cooperative learning structure and the weakening of resistances opposing change. Key for the success of the implementation has been the adequate selection of ten competencies (client orientation, versatility, entrepreneurship and innovation, systemic thinking, responsible and active learners, facilitative leadership, teamwork and cooperation, human interaction, organizational development and performance, and organizational leadership), the implementation of a team organization coherent with the model, from leader centered to a self directed empowered teams, and the delivery of appropriate external training interventions, designed to foster the development of the above competencies. Preliminary results show that students have developed technical and social competence to the point of being offered significantly more internships and permanent positions by the partner chemical manufacturer.

It should be noted that this chapter presents the final educational model proposed for competency development at the ETSEQ. The material presented, which is the main contribution of the thesis, will be published as such in the International Journal of Engineering Education (see Appendix D). Since the current work started from the successful IDP models developed at the ETSEQ depicted in Figure 1.4 and the partnership with the Dow Chemical Company back in 1997, many variations of the IDP model had the opportunity to be tested on a restrictive, unofficial basis. The impact of official adoption by the ETSEQ of the IDP in 2000/01 has permitted to recover some of the past experiences very recently, like the adoption of the 1st and 4th year model in the second year of the ChE program. This is the reason why the current model of Figure 4.1 already reflects this and other currently underway realizations. The surveys presented and discussed in Chapter 3 reflect the state of the IDP system prior to implementing or in the initial stages of testing any of the key elements of the current competency based educational model. This gap has been inevitable given the personal situation of the author of this work as well as the idiosyncrasy of the Catalan University System.

4.6 References for Chapter 4

- [1] Kolb, D. A.: *Experiential Learning. Experience as the Source of Learning and Development*, Prentice Hall, Englewood cliffs, New Jersey, **1984**
- [2] Henrich, J.; McElreath, R.: *The Evolution of Cultural Evolution*, *Evolutionary Anthropology*, 12, 123-135, **2003**
- [3] Bandura, A.: *Social Foundations of Thought and Action: A Social Cognitive Theory*, Prentice-Hall, Englewood Cliffs, NJ, **1986**
- [4] Bandura, A.: *Social Learning Theory*, Prentice-Hall, Englewood Cliffs, NJ, **1977**
- [5] Bandura, A.: *Self-Efficacy: The Exercise of Control*, Freeman, New York, **1997**
- [6] Pajares, F.: Self-Efficacy Beliefs in Academic Settings, *Review of Educational Research*, 66(4), 543-578, **1996**
- [7] Giralt, F.; Medir, M; Their, H.; Grau, F.X.: A Holistic Approach to ChE Education / Part 1, Professional and Issue-Oriented Approach, *Chemical Engineering Education*, vol.28, pp. 122–127, Spring **1994**
- [8] Giralt, F.; Fabregat, F.; Farriol, X.; Grau, F.X.; Giralt, J.; Medir, M.: A Holistic Approach to ChE Education / Part 2, Approach at the Introductory Level, *Chemical Engineering Education*, vol.28, pp. 204–213, Spring **1994**
- [9] Giralt, F.; Herrero, J.; Medir, M.; Grau, F.X.; Alabart, J.R.: How to Involve Faculty in Effective Teaching, *Chemical Engineering Education*, vol.33, pp. 244–249, Summer **1999**
- [10] Giralt, F.; Herrero, J.; Medir, M.; Grau, F.X.; Alabart, J.R., Medir, M.: Horizontal and Vertical Integration of Education into a Human-Centered Engineering Practice in Design Processes, *Journal of Engineering Education*, pp. 219-229, April **2000**
- [11] McClelland, D.C.: Testing for Competence rather than Intelligence, *American Psychologist*, 28, pp. 1-24, **1973**
- [12] Prados, J.W.; Proctor, S.I: What will it Take to Reform Engineering Education, *Chemical Engineering Progress*, pp. 91-96, 96(3), **2000**
- [13] Bloom, B.S.: *Taxonomy of Educational Objectives. 1. Cognitive Domain*, Longman, New York, **1984**

- [14] Huysse, G. J.: From the Classroom to the Boardroom, *Quality Progress*, pp. 81-82, November **1997**
- [15] Buonopane, R.A.: Engineering Education for the 21st Century: Listen to Industry!, *Chemical Engineering Education*, pp. 166-167, 30(3), **1997**
- [16] Wearne, S.: *Management Skills: Not Just for the Boss*, *The Chemical Engineers*, pp. 26-27, August **2003**
- [17] Farr, J.V.; Merino, D.N.: *Education Entry-Level Engineers: Are Broad-Based Business/Managerial Skills a Key to Sustaining the US Innovation-Based Economy?*, *International Journal of Engineering Education*, 19(2), pp. 252-259, **2003**

The Competency Based Educational Model

- [18] Witt, H.J.; Alabart, J.R.; Giralt, F; Herrero, J.; Medir, M.; Fabregat, A.: Development of Coaching Competencies in Students through a Project-based Cooperative Learning Approach, 32nd ASEE/IEEE Frontiers in Education Conference, Boston, November 2002. *Proceedings – Frontiers in Education Conference*, 2, F2A/1- 6, IEEE cat. no. 02CH37251, **2002**
- [19] Rugarcia, A.; Felder, R.M.; Woods, D.R.; Stice, J.E.: The Future of Engineering Education: Part 1, a Vision for a New Century, *Chemical Engineering Education*, pp. 16-25, Winter **2000**
- [20] Accreditation Board for Engineering and Technology, <http://www.abet.org>, accessed June 30th, **2004**
- [21] Investing Efficiently in Education and Training: an Imperative for Europe, Communication from the European Commission, COM 779 final, **2002**
- [22] The Dow Chemical Company: *Implementing Change Effectively. Leaders Guide*, Midland (MI), not published, October **2001**
- [23] Conner, D.R.: *Managing at the Speed of Change*, Villard Books, 1st edition, New York, **1993**
- [24] Senge, P.M.: *The Fifth Discipline: The Art and Practice of the Learning Organization*, Currency Doubleday, Century Business, **1990**
- [25] Grunwald, W.: Psychologische Gesetzmäßigkeiten der Gruppenarbeit, *Personalführung*, 740-750, September **1996**
- [26] Rummler, G.A.; Brache, A.P.: *Improving Performance: How to Manage the White Space on the Organization Chart*, 2nd Edition, Jossey Bass Inc. Publishers, San Francisco, **1995**
- [27] Woods, D.R.; Felder, R.M.; Rugarcia, A.; Stice, J.E.: The Future of Engineering Education. Part 3. Developing Critical Skills, *Chemical Engineering Education*, pp. 108-117, Spring **2000**
- [28] Felder, R.M.; Woods, D.R; Stice, J.E.; Rugarcia, A: The Future of Engineering Education. Part 2. Teaching Methods that Work, *Chemical Engineering Education*, pp. 26-39, Winter **2000**
- [29] Smith, K.A.: *Project Management and Teamwork*, McGraw-Hill Higher Education, **2000**
- [30] Kolb, D.A.; Boyatzis, R.E.: Goal Setting and Self Directed Behavior Change, *Human Relations*, Volume 23, Number 5, pp.439-457, **1967**
- [31] McClelland, D.C.: Toward a Theory of Motive Acquisition, *American Psychologist*, 20, 321-333, **1965**

The Competency Based Educational Model

- [32] The TRACOM Group: *Enhancing Team Performance*[®], *A Process and Tools for Developing Teams, Facilitators' Guide*, **1990-1995**
- [33] Rollo, J.: Performance Management, GOAL/QPC and Competitive Advantage Consultants Inc., Salem NH, **2001**
- [34] Spencer L.M.; Spencer, S.M.: *Competence at Work: Models for Superior Performance*, John Wiley & Sons, New York **1993**
- [35] Felder, R.M.; Stice, J.E.; Rugarcia, A.: The Future of Engineering Education: Part 6, Making Reform Happen, *Chemical Engineering Education*, pp. 208-215, Summer **2000**
- [36] The European Foundation for Quality Management: EFQM Excellence Model, Brussels, **2003**

Table 4.1. Team organizations of Figure 4.1 defined according to responsibilities and activities of members

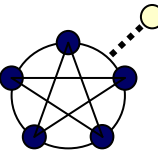
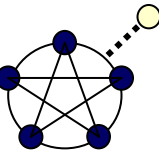
Responsibility of Activities Leader Shared between Leader & TM (not necessarily 50/50/ Shared between Instructor & TM (not necessarily 50/50/ Team Members (TM) Activities	Leader directed	Leader centred	Shared leadership	 Self-managed	 Self-directed
1.- Formulate team objectives (project scope)					
2.- Identify learning issues and apply learning processes					
3.- Establish team norms					
4.- Communicate with project clients					
5.- Communicate with project sponsors					
6.- Provide feedback to team members					
7.- Manage conflicts					
8.- Manage decision making process					
9.- Design and apply a balance of consequences system					
10.- Define and improve teamwork procedures					
11.- Determine the required reviews and approvals					
12.- Manage project's risks					
13.- Schedule project's activities and create a project budget					
14.- Establish quality standards for activities					
15.- Assign activities to team members					
16.- Monitor project progress					
17.- Integrate new team members					
18.- Assess individual performance and competency development					
19.- Evaluate team performance					

Table 4.2. External interventions supporting the educational model and the competency structure

Interventions	Description
Enhancing Team Performance[®] (ETP)	Modular workshop [Fundamentals; Common Purpose; Team Capabilities; Change; Norms; Communication/Conflict; Recognition/Reward; Operating Procedures; New Member Integration; Evaluation]
Cultural Diversity	Workshop based on the resource <i>Managing Across Cultures[®]</i> by Trompenaars, Hampton-Turner, 2000, to develop concepts of culture and relate cultural patterns with behaviours and actions (in collaboration with Dow)
Organizational Development	Modular workshop jointly designed with Dow to build the foundation for core values and to enhance competencies like client orientation and system thinking [organisational design; strategy development & implementation; business processes]
Facilitative Leadership	The learning resource selected is <i>Human Interaction[®]</i> developed and sponsored by Witt & Partner. It deals with the complexity of resolving conflicts and leading teams without exercising managerial power
Global Empowerment	Based on Dow's <i>Global Empowerment Assessment Workshop</i> to help tracking the progress of team organizational stages toward empowerment, to ensure that team members and leaders display appropriate behaviours, and to become aware of the processes and methods available to develop, implement, evaluate and improve continuously the management system of any organisation

Table 4.3. Operational definitions of the ten competencies selected according to the concentric structure of Figure 4.2

Client Orientation	The ability to identify and listen actively to clients, to anticipate and identify what clients need and value, and to seize opportunities in a responsive manner
Versatility	The ability to be open to changes and new information. To adapt behaviour and work methods in response to new information, changing conditions, or unexpected obstacles. To deal effectively with pressure; maintain focus and intensity; remain optimistic and persistent even under adversity. To be resilient and capable of dealing with disappointments and setbacks
Entrepreneurship & Innovation	The capability to identify and solve problems with creativity, to have bias for action, and take appropriate risks. The confidence to try something different without being afraid of making mistakes. The determination and ability to challenge the status quo with new and valuable ideas and to apply existing ones in new and improved ways
System Thinking	The ability to deliver technical capability based on a vision of the big picture and managing any individual or collective endeavor according to a holistic model. The capacity to recognize patterns and complete the big picture from partial information
Responsible & Active Learners	Takes responsibility for own learning and development by acquiring and refining of technical and professional skills needed in job related areas. Obtains developmental opportunities proactively. Applies knowledge and information gained as appropriate
Facilitative Leadership	The ability to help other people improve performance, promote an environment that fosters the development of others, influence and guide others toward identifying and achieving objectives, provide purpose and direction, and motivate and enthuse others
Teamwork & Cooperation	The capability to contribute to effective team output by cooperation, participation and a commitment to share vision and goals, and to achieve interdependence with personal accountability
Human Interaction	The ability to communicate effectively in interpersonal and group situations, whether through written or oral means
Organizational Development & Performance	Contributes effectively to increasing organisational performance by the knowledge of relevant management methodologies and their implementation
Organisational Leadership	Establishes directions, objectives and resource requirements required to respond to organisational needs and opportunities. Thinks strategically about longer term needs and the capabilities required to address these needs

Table 4.4. List of compulsory and elective courses, and external interventions supporting the educational model and the competency structure

Year	Course	Semester	Hrs	Type
1	Enhancing Team Performance [®] (ETP) modules: <i>Fundamentals, Change, Team Operating Procedures, New Member Integration, Recognition/Reward</i>	1	15	External compulsory
2	ETP modules: <i>Common Purpose, Team Norms</i>	1	6	External compulsory
	<i>Communication Techniques for Chemical Engineers</i>	1	30	ChE elective
	<i>Cultural Diversity</i>	2	15	External compulsory
3	ETP modules: <i>Communication/Conflict, Team Capabilities, Evaluation</i>	1	9	External compulsory
	<i>Organizational Development</i>	1	20	External compulsory
4	<i>Project Management</i>	Yearly	60	ChE compulsory
	<i>Project Management in Practice</i>	Yearly	120	ChE compulsory
	ETP complete suite of modules	1	30	ChE elective
	<i>Facilitative Leadership</i>	1	10	External compulsory
5	<i>Empowerment Journey</i>	1	30	External compulsory

Table 4.5. Example of the assessment process of the integrated project related activities at the first year of ChE studies

Assessed Element	Who is assessed?	What is assessed?	Weight (%)	Who assesses?	How to assess?
WHAT? (Final results)	Team	Final report	25	1 st year project co-ordinators	According to acceptance criteria
		Poster	25	1 st year professors (Clients)	According to acceptance criteria
		Learning of instructional objectives		1 st year professors (Clients)	Each client asks questions about the content of the project to a member of the team chosen at random. The score is the same for all team members
HOW? (Processes to achieve final results)	Individual	Development and use of competencies	50	1 st year students	1 st year students carry out a self assessment by using a competency form designed specifically for this purpose from the dictionary of Spencer and Spencer [34]. Once completed, 1 st year students meet with their team leaders to discuss results. They clarify and reach consensus. If consensus be reached, differences are recorded and a professor of the Project Management in Practice course (sponsor of the project) mediates to reach a final compromise