

E2ML  
Educational Environment Modeling Language

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## **Abstract**

This study moves from the consideration of the communication dynamics within the instructional design practice. With the introduction of electronic media, the design of educational environments in Higher Education has ceased to be a craftsmanship activity, and has acquired some features proper of mass production. This makes communication a more and more critical issue in design.

The original goal of this work is to propose a communication tool that can support designers in this new and more challenging professional context. The result is E<sup>2</sup>ML, a conceptual design language with a simple notation system. The method proposed is that proper of design and applied sciences: critical observation of needs and practices aimed at the definition of a new tool.

The Introduction is devoted to setting the research problem and to introduce a new perspective on education and technologies, taken from the work of B. Lonergan. Chapter I proposes a review of the existing literature about instructional design, which includes also the more recent developments concerning Learning Object and Learning Technologies metadata standards. Chapter II introduces E<sup>2</sup>ML, in its simple and advanced versions, while Chapter III answers some questions about its conceptual background and exploitation, and explores the relationship between E<sup>2</sup>ML, other Instructional Design models and Learning Technology standards. Chapter four collects several case studies that illustrate the use, benefits and shortcomings of the new language. Chapter V finally proposes a first evaluation framework for such a language along with data collected from a small study conducted with experienced instructional designers.



# Educational Environment Modeling Language

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*It is, indeed, impalpable, but also it is powerful. It pulls man out of the solid routine of perception and conation, instinct and habit, doing and enjoying. It holds him with the fascination of problems. It engages him in the quest of solutions. It makes him aloof to what is not established. (...). It is the cold shrewdness of common sense, the disinterestedness of science, the detachment of philosophy. It is the absorption of investigation, the joy of discovery, the assurance of judgment, the modesty of limited knowledge. It is the relentless serenity, the unhurried determination, the imperturbable drive of question following appositely on question in the genesis of truth.*

(Lonergan 1957, p. 349)

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## INTRODUCTION

# LEARNING AND ELEARNING

*“Such learning is not without teaching. For teaching is the communication of insight. It throws the clues, the pointed hints, that lead to insight. It cajoles attention to drive away the distracting images that stand in insight’s way. It puts further questions that reveal the need of further insights, to modify and complement the acquired store.”*

*“For teaching is a vast acceleration of the process of learning. (...) Archimedes had to rack his brains to discover what every schoolboy can be taught.”*

*(Lonergan 1957, p. 174 and p. 289)*

*As Tzu-gung was traveling through the regions north of river Han, he saw an old man working in his vegetable garden. He had dug an irrigation ditch. The man would descend into the well, fetch up a vessel of water in his arms, and pour it out into the ditch. While his efforts were tremendous, the results appeared to be very meager.*

*Tzu-gung said, "There is a way whereby you can irrigate a hundred ditches in one day, and whereby you can do much with little effort. Would you not like to hear of it?" Then the gardener stood up, looked at him, and said, "And what would that be?" Tzu-gung replied, "You take a wooden lever, weighted at the back and light in front. In this way you can bring up water so quickly that it just gushes out. This is called a drain-well."*

*Then anger rose up in the old man's face, and he said, "I have heard my teacher say that whoever uses machines does all his work like a machine. He who does his work like a machine grows a heart like a machine, and he who carries the heart of a machine in his breast loses his simplicity. He who has lost his simplicity becomes unsure in the strivings of his soul. Uncertainty in the strivings of the soul is something which does not agree with honest sense. It is not that I do not know of such things; I am ashamed to use them."*

(Morgan 1998, p.18)

University students have nowadays the opportunity to work together with colleagues on the other side of the ocean, to exchange experiences or to invite a famous speaker for a videoconference. Youth in disadvantaged parts of the world can access education programs before restricted to Western European and North American students, thus introducing a lively professional and economical experience in their countries. The learning process itself is enhanced by the introduction of multimedia resources, and by taking advantage of electronic communication. All this happens, which was before impossible; and it can happen as new information and communication technologies – the *e-* in *eLearning* – enter the process of education.

Yet the introduction of new technologies in education is a twofold process. On the one side learning stretches its boundaries to new frontiers, including interactive software, multimedia presentations, computer-supported collaborative applications and many other enhanced forms of learning; on the other side, the fast change that has occurred has left a blurred suspect that something important, which was engendered in the Western traditional<sup>1</sup> form of education was lost.

## **eLearning as Learning Through Artifacts**

Electronic technologies are indeed machines, artifacts conceived, designed and developed for handling information and supporting communication. Artifacts are, in this case, tools that support a particular activity. The introduction of a tool in any human activity brings to a re-assessment of the whole activity, to a (partial) redesign of it, and to a different perception of the actors involved, concerning the action itself, the task and their role in accomplishing it (Vygotsky 1978).

The first and perhaps more evident change is for teachers: their professional activity cannot be conceived as before: it evolved to include new skills, technological and technical competencies and, most of all, to take place in a very different social and professional environment. On the other side of eLearning, the new challenge is *e-teaching* (Dewar & Whittington 2000).

A particular part of teaching is educational design (or instructional design). Educational designers are people and teams in charge of shaping educational activities and environments responding to the

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<sup>1</sup> About the relativity of the idea of “traditional” form of education see (Cantoni & Di Blas 2002).

particular needs of the learners. The Western traditional *teacher* profile includes the design activity, but the definition of *educational designer* also embraces human resources and training corporate departments, health system regional training program managers, etc. New tools can now enhance the designers' work, who can now tackle new situations; on the other hand, they raise a new set of issues. In one word, their work has grown more and more dependent on technologies. The complexity to be managed in designing and developing an "eLearning course" (anything it could mean) is much more than these professionals were accustomed to.

The risk, often depicted as a necessary outcome by IT-skeptical, is exactly Tzu-gung's issue. Are we loosing our *simplicity* and becoming *unsure in the strivings of our soul*? Is teaching and learning becoming more and more near to an automatic process, where machines are taking the lead?

Actually, relying on technologies in teaching and learning may give raise to a dangerous misunderstanding: that useful, usable, engaging and up-to-date tools are enough to guarantee learning. This is not at all the case, exactly as a perfect guitar is not a warrant for a good blues. The fact is, even more challenging and stimulating, that designers and teachers need to know how to exploit the new tools they have at disposal.

Further, let us consider that, as McLuhan claimed:

*Media, by altering the environment, evoke in us their unique ratios of sense perceptions. The extension of any one sense alters the way we think and act – the way we perceive the world.*

(McLuhan 1967)

So, what kind of human interaction results from a widespread introduction of technologies in such rich activities as teaching and learning?

McLuhan also points out that

*Our official culture is striving to force the new media to do the work of the old.*

(McLuhan 1967)

McLuhan addressed the clash between print versus the electronic media (at that time, television). The same clash - or at least the same cultural issues – is currently at stake when new technologies enter the classroom. This situation should be a powerful catalyst and motivator for critically rethinking the design of education in general and at all levels. This work and E<sup>2</sup>ML are a result of this concern.

The following paragraphs will present some general issues in order to outline the context in which this research was performed. After that the focus of the current work, its object, goals and method will be introduced.

## **Teaching from Craftsmanship to Production**

Anyone born in Europe before 1980 probably recalls, in her/his university experience, a number of courses, each held by a professor, maybe with some teaching assistant. The conception of each course and its cultural perspective was completely demanded to the professor, and the practical activity of giving lectures as well. Teaching assistants probably lent a hand in developing transparencies or photocopying materials. Although some variation was possible (such as having assistants holding exercise sessions or producing a course-pack), this was the end of the story. And each professor came from that very tradition of academic teaching and learning, so that that particular form of educational activity was perceived as natural.

The main transformation that re-shaped the profession of a teacher is that the very idea of *course* has extended to completely unexplored dimensions (Bates & Poole 2003). A course Web site may contain the transparencies in digital format, and each set of them may be coupled with an online self-assessment test and a Web resource page that provides pointers to other relevant information.

Moreover, the contribution of an external lecturer, who gives a talk in videoconference, may be recorded and made available online. All these materials can be used as input for the teamwork discussion, which should produce, by the end of the course, a multimedia presentation about one of the course sub-topics. Moreover, as a great part of the learning activities take place online, the course target can be extended to off-campus students, as well as to a group of students from a partner university on the other side of the ocean. An institutional strategy for fostering teaching with technologies may add a stress element to the picture.

No matter that such scenarios are not yet common, the point here is that it is *realistic*: such a course would be feasible in virtually any academic context. This fact raises an issue for the educational designer: how could I exploit these possibilities for my job, for developing good courses and help learners achieve their goals? Of course, one can deliberately choose not to consider them, to go the old path and work the way one is used to – but would you call that a professional?

The introduction of new media in education has made the design activity a more and more structured and interdisciplinary process (Szabo 2002), where a lone-ranger professor is not enough to cope with it all. Under some respect, teaching is thus developing from craftsmanship to a product-like production process (Cantoni & Di Blas 2002). Is this a positive evolution, that will bring to a better education? This broad issue is not directly at stake here, and the doubts expressed by Tzu-gung's old men are all legitimate. Yet one of the goals of this work is providing some insights for understanding when and how a production-like design of education can be a sensible and effective choice.

Let's see some aspects of the complexity that technologies bring into education.

#### *Communication for Interdisciplinary Teamwork*

A successful integration of technologies in the educational activity is not a matter of mere will. The simple decision to use technologies is not enough to integrate them in education – as it is probably the experience of many high school and university teachers.

Let's take some examples. The distant teacher holding videoconference lectures needs technical competences for installing and running a video camera and a microphone, for connecting to the videoconference server, for uploading and sharing documents, etc. Unless s/he masters them, a technical assistant should take care that everything works during lectures, and help in preparing them. The same can be said if printed materials should be turned into digital format to be distributed per email or via a Web site. A number of technical activities are required for controlling, managing and updating the technological support; and not all of them can be supposed to increase the teacher's burden. Technical competencies are required at any moment. In a school, rooms have to be built just once, and simple routines can keep facilities going even if a teacher decides to invert a sequence of planned lectures. But if this happens in an online course, it should be reflected in a change of the hypermedia application supporting it, and would probably require technical support<sup>2</sup>.

And it is not just a matter of technical competency. Even more harmful than using new media without adequate technical skills is using them without a strategy. How can the senior faculty of Statistics manage an online activity, or translating his explanatory aptitude into digital self-learning materials? Technical competency should be coupled with pedagogical insight, and these two should as well be matched with the specific disciplinary needs and patterns of each subject matter (Szabo 2002).

This is why, when it comes to eLearning, the subject of teaching, intended as the conception, design, development and enactment of a formative action, is an interdisciplinary team (Greer 1991).

The profiles in the team depend on the specific context. Generally, a team should involve "(...) any combination of subject experts or faculty, project manager, instructional designer, graphic designer, computer interface designer, desktop editor, Internet specialist, and media producer, depending on the design of the project" (Bates 1999, p. 70; see also Achtemeier, Morris & Finnegan 2003). External partners too may have a role in delivery or supply (see e.g. Pigni 2002, Ardizzone & Oliveto 2002). In any case, the more technology-dependent the educational environment is, the more interdisciplinary the design team should be.

Each profile has its specific role in course development. The "professor" has been decomposed into a number of different specialized profiles: what was a craftsmanship activity has evolved to a more

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<sup>2</sup> This is a hint at the fact that, as shown in (Bates 1999), fixed and variable costs in face-to-face and technology-based education are different.

complex collaborative process, where the issue of communication acquires new relevance. Different professionals have indeed different technical languages, and misunderstanding is a pitfall that can endanger a successful development (effectiveness of communication). Moreover, it is necessary to find a trade-off between the savings due to the specialization of each activity in the process, and the costs of communication among the different actors (efficiency of communication). These problems clearly call for the definition of a standard or *lingua franca* among the different profiles involved in educational design.

Other issues are at stake too. How can the final learning activity maintain its overall consistency? Who will be finally in charge of establishing a relationship with the students? Who is responsible for the whole course? How to seamlessly merge the contributions of all profiles into one final “product”?

### *A Structured Design Process*

As in any project, and as a consequence of its intrinsic interdisciplinary character, the overall complexity of educational design can be managed by assigning specific tasks to several specialists and by organizing the production process into phases, following a project management approach (Bates 1999; Greer 1992). The development of a technology-based course is a project that involves several dimensions: budgeting, technology infrastructure, institutional commitment, etc. This work only focuses on pedagogical design, temporarily concealing the other dimensions.

Under this perspective, the discipline of Instructional Design has proposed several models for guiding the design and development of education. Some of them will be presented in Chapter I. Although these models can be useful even in non-technological situation, they become necessary in order to achieve satisfactory performances in a technology-enhanced environment. For example, planning in advance is in such cases much more essential, as any change during the course enactment should be echoed in a change in the technological apparatus. This is a great difference from a non-technological situation, in which a teacher could change a lecture simply by taking a different set of notes. Good planning can therefore dramatically save redesign costs.

### **Potentialities and Limits**

Over and over in the last decade, Information Technologies (IT) skeptics and technology enthusiasts gave life to a debate in which they take the part of the old man and Tzu-gung. The former say that new technologies will spoil the educational system and prevent teachers and learners to come in touch as human beings; the latter that finally eLearning has freed learners from the tyranny of teachers, and that they can now enjoy much richer educational experiences. Who is right?

This kind of issues, at one time relevant and sensitive, do not deserve a definitive binary solution, yes or no. Several experiences, like the ones presented later on in this work, or like those reported in many of the eLearning conferences in the last years, show that no definitive rule can be defined. Technologies are tools, and human actors *use* tools. The outcome thus depends of course on the tools, but also on the will of the users, their goal with respect to the choice of that specific tool, their ability in using that, and on serendipity.

It is not uncommon that an eLearning application, perfectly tailored to the needs of one user, will result clumsy and unusable for another. The same eLearning formula may result in a high-quality experience in South America, but fail in Africa.

Let's take an example. Imagine that you wish to invite a famous professor in Neuroscience to hold a lecture on “The Brain and Language” in a university in Center Europe. The travel and lodging expenses make that difficult, and your guest's agenda declares it is definitely impossible. Someone suggests that you use a videoconferencing system – no travel, no hotel and your guest just has to allocate three hours for a talk of two-and-a-half. And, with some technical assistance, it works. Now, the same topic is found relevant for a set of activities in a High School class, where students are 17 years old. You wish to invite a speaker, but it does not work. Would you use a videoconference? Would that fit to your audience, would the students be able to keep attention? A less famous but live speaker would make a boring small-video-bad-audio lecture-like-TV enjoyable.

Technologies offer new possibilities, but at the same time impose new limitations. From the designer's perspective, the issue is identifying the relevant parameters for assessing the pros and cons of technologies in each particular situation. Design is not about general theories, but about solving particular problems. Theories and principles offer spectacles that may help designers getting an insight of their problem.

This issue is extremely relevant in education, where any failed educational experience will leave traces on the learners involved – at least the bitter taste of an unexploited chance.

## Designing Educational Environments

After this forcedly short exploration of some issues related to the introduction of new media in education, the following paragraphs will introduce the specific research object and declare some tenets that ground the whole work. Finally, the research goals and method will be outlined.

The object of this work is *the design of educational environments*, and a definition of the phrase may be the first step.

### The Perspective of Design

As the next paragraph will make clear, explicit learning is an intentional activity that requires the learner's personal involvement. But the learning dynamic can be supported in a number of ways: it is the role of the teacher and of any other teaching role, as well as the role of the whole environment in which learning happens.

This research work takes the perspective of teachers as educational designers, i.e. of the people conceiving, designing and setting up educational environments. This activity also involves the production of specific content and tools, but its pivotal point is planning educational activities (Lawyck 2002).

The reference discipline is therefore *Instructional Design*, which can be defined as

*(...) The systematic and reflective process of translating principles of learning and instruction into plans for instructional materials, activities, information resources and evaluation.*

(Ragan & Smith 1999, p. 2)

In this work, the term *educational design* is used, thus indicating a broader scope of the educational activity with respect to instruction. An excellent discussion of these terms is proposed as well in (Ragan & Smith 1999).

Men, differently from animals, first conceive in their minds the artifacts they want to realize. Even bees, or ants, when building their incredibly complex cities, just do it, following an instinct. Men think, first create the object as a mental representation, and *then* realize it.

Conceptual tools, modeling languages, standard practices, can support the mental activity of design when the object is particularly complex. It is indeed the ability of the architect, of the cook, of the painter, of the musician, and of anyone producing an artifact. Understanding the educational designers' work and providing them insights and tools may be a constructive contribution to the exploration of one of the most promising technological frontiers of the present days.

## Educational Environment

In order to understand what the components of an educational environment are, one may start from a definition by UNESCO in a document about schooling for cases in which few resources and facilities are available, and just the essential can be taken care of.

*What is a learning environment - Desks? Walls? Blackboard? A few windows? For children, (an educational environment) is where learning takes place. Children learn best through their interactions with the teachers, parents, their peers, and the world around them. Since interaction is one of the most important elements of learning, education programs can be started with very few facilities and resources. The space, the objects in the space, the organization of time, and human interactions are all parts of the learning environment. If the school buildings have been destroyed, learning can take place at home, in a shelter, or outdoors. In fact, many refugee schools start in the open in the shade of a tree.*

(UNESCO 2002)

While it is clear that more resources can enhance a learning environment in terms of possible activities being carried out, facilities are not the central point in the definition of learning environment: the interactions among the persons in an educational environment, each with his or her own role, are the core element.

A more structured definition is the following, provided by an academic committee on classroom use at Purdue Indiana University. It also focuses on the dichotomy interactions/facilities, and tries to trace the line that divides them.

*Just as a university's buildings facilitate its work, so a learning environment facilitates student learning. While the emphasis is on 'facilitates', formal learning has long been directly associated with the classroom, the blackboard, the lecture, and the textbook. This view of a learning environment has more recently been extended to include distance education sites, common areas such as halls and outdoor green spaces, amphitheatres, banks, newspapers, libraries, field trips, television, and, quite recently, the Web. We propose that a learning environment is an atmosphere more than a place; an opportunity for sensory perception, rather than a physical entity bound by place and time. It is a tutor sitting down with a student. Our working definition is: A learning environment is a physical, intellectual, psychological environment, which facilitates learning through connectivity and community. This definition then may include, in addition to the standard settings, environments such as distance education, homes, computers, offices, businesses and shopping malls.*

(IUPUI 1997)

The role of facilities is improving the learners' activity and facilitating interactions. An environment has a function, a meaning and finally a value as much as people use it. Calvani expresses another useful point of view.

*An environment intentionally designed for the actualization of educational processes, i.e. significant developments of the personality involving cognition and adaptivity.*

(Calvani 1997, p. 157. Tr. Eng. Luca Botturi)

The stress is here on design. Earth does not naturally produce educational environments, even if we can elect a natural location for education. What turns a place into an educational environment is the

human activity of teaching and learning that takes place in it. Then we build classrooms, write books, shoot movies, etc. for improving teaching and learning.

But an educational environment is much more than objects, tools and facilities. Designing an educational environment means figuring out a set of goals, rules and possible interactions in order to let learning happen; only afterwards the production of the objects, tools and facilities can be sensibly addressed. Under this respect an educational environment is an artifact as object of design (given that also rules are social artifacts), but it is a living dynamic once that it is in operation, and that real people actually interact in it. As Curran (1976, quoted in Cantoni & Di Blas 2000) put it, “Learning is persons”.

A useful comparison might be that of theater. The text of a play is an artifact, written by its author, and the project for its *mise-en-scène* is an artifact too: choreography rules, special ways of acting, objects on the stage conceived by the director and her/his team. But the outcome of a particular show is the interaction among the actors, the play and the audience: this cannot be designed and is highly unpredictable. More than the word *artifact*, this is properly described by the term *event*. An educational environment is therefore an artifact conceived and designed for fostering the events of learning.

According to these views, a more general and synthetic working definition can be formulated, which will be used all along this work: an educational environment is a system composed by actors, interactions and roles, goals and objectives, contents and materials, spaces and tools, resources and constraints along with an overall strategic, or holistic, organization of these elements, where the action of teaching and event of learning can favorably take place. More shortly, it could be worded as follows: *an educational environment is a complex holistic system designed as a context for teaching and learning*.

The three elements in this definition are the main variables of an educational environment. First of all, the word *system*, i.e. an ordered and structured whole made of different parts, each defined by its particular functions and its interactions with other elements. From this point of view, educational environments are eclectic, and their elements can be of different natures (*complex*): locations, tools, learning materials, experiments, didactic roles and actors, etc. Their integration in one *holistic* system is the main issue for the designer. S/he is in charge of defining its rationale and making it work.

Then the second and third elements: *teaching and learning*. An educational environment is never general, but tailored to a specific target and to specific people acting – teaching or learning – in it: grade 3 children, university students, professionals, etc. They are the subject of knowledge in action. Learners are therefore the first *users* of an educational environment: their characteristics, behaviors, needs and expectations are the primary source of requirements. Nevertheless, learners are not the only actors in the systems: their interaction with the other instructional roles is the relevant issue: teachers, instructors, tutors, facilitators, etc.

Finally, any real educational environment is bound to a specific kind of knowledge and to a specific knowledge object or subject matter. An academic course is different if its subject is Art History or Geometry, GPRS Systems or Accounting. On the other hand, taken the same subject, the course would be different if it aims at introducing learners in a new area, or if updating them to the last tools and practices in the field. The (knowledge) matter is one of the main variables in educational environment design, and is the line on which general principles of pedagogy must melt with disciplinary and specific values and constraints. Knowledge as a cognitive, behavioral or attitudinal change in the subjects involved is the result expected from an educational environment.

## Focus Context

This work will focus on Higher Education, in order to consider a more restricted – even if not at all narrow – setting, well defined by its student target and institutional context. Higher Education includes universities, colleges and technical high schools, post-grad programs and Master of Arts. To the purposes of this work, the definition of Higher Education can be extended as well to continuing studies and corporate training programs.

While results of this work are applicable to any context with minor modifications, all the examples and case studies will be taken from the academic context.

## Four Tenets and a Working Hypothesis

Four tenets should be analyzed before declaring the goals of this research work and its method. They will not be the research focus, but they represent the author's overall idea of education, and could be better discussed in a philosophical essay. The reader who finds her/himself in disagree with them has two choices. The first is closing the book and forget it; the second is taking them as working hypotheses in order to see where they lead, if they actually make some of the issues introduced above at some degree more understandable.

### Tenet 1: Learning as an Intentional Activity and a Process

John Searle (1983), in his book devoted to the study of intentionality, defined *intention* as a directedness, or *aboutness* to an object. From his perspective, an act can be regarded as an intentional performance. Through fine theoretical and logical reasoning and a number of examples, the philosopher defines prior intentions as causes of intentions in action. Intentions are inscribed into a network, within one person's experience, of intentional states, and are grounded in a less defined general cognitive background.

Searle then states that

*(...) I believe it is easy to extend the account to actions where there is no bodily movement or where only a mental act is performed.*

(Searle 1983, p.102)

In this sense, states Searle, even perception has at least a part of intentionality. Learning is an intentional activity. The desire of knowledge, or drive to know, is generated by what Aristotle called wonder. One does not wonder in general, but wonders of something – and here is what makes learning intentional. Learning is caused by an intention in action to handle, understand and intellectually possess the desired object of knowledge.

Searle's concept of intentionality is paramount as it provides sound theoretical foundations for connecting learning and knowledge to the world of experience, to situations and objects outside our minds with which we interact as whole human beings: with our mind, heart and body.

This theoretical remark is supported by the common experience of teaching, which often finds the obstacle of scarce motivation, of scarce "directedness" of the learners' will toward the object.

Hence come three main consequences:

1. Learning involves not only intelligence, but will, freedom and affectivity as well. This is echoed in a part of Instructional Design research, for example in Keller's ARCS model (see e.g. Keller 1983) and Gagné's nine events of learning (Gagné, Briggs & Wager 1992). Both will be discussed in Chapter I.
2. As intentions are mental states of a subject, none can take the learner's part in learning: if I want to learn, I have to perform the act of learning, to go through the process, just like eating or breathing: nobody can get the job done by someone else. This means that:
  - a. The learner is the main active role in education. More than constructivist learning theory proposes (learners do not acquire knowledge, they produce it), with a sort of involvement in the learning activity which requires the whole person.
  - b. No skilled instructional activity can guarantee a learning outcome; even less can technologies be a warranty for learning to take place. Any educational system can simply foster or promote the learners' activity, or at least not hinder it.
  - c. The teacher should work with learners' intentions: direct prior intentions, provide the best possible conditions for learning to occur, stimulate prior intentions into intentions in action at the right time, foresee unintentional outcomes and eventually frame them.

The intentional activity of learning is enacted as a process. Learning does not happen all of a sudden (as understanding does), but in a stepwise manner. The analysis and understanding of the learning process, and the following definition of a hypothesis about how we learn, is the basis for formulating the principles that can support the design activity.

I will not spend time here in a summary of learning theory that many other authors did better than I could ever do. I'd rather introduce a novel contribution to this fundamental discussion.

During this research, I came across the work of Bernard J. Lonergan<sup>3</sup>, a philosopher, economist and scholar in Theology that proposed a synthetic view of the learning process, perfectly in step with Searle's definition of intentionality, and therefore with the main approach to teaching and learning proposed here. Although not widely known in Education and Psychology, Lonergan is a referenced scholar in Philosophy and Theology, and an in-depth study of his decennial work revealed its insightfulness in approaching several design issues. Moreover, its effects in shaping a design tool proved to be effective; namely, while dealing with the definition of learning goals, Lonergan's "understanding of understanding" was extremely fruitful, as accounted in Chapter II.

The introduction of a novel contribution in Instructional Design corresponds to the natural interdisciplinarity of this field of study, and may bring to interesting results through the interaction with other contributions.

The next pages are therefore devoted to discuss it, as it can be a positive contribution to a practical definition of teaching.

### *Experience, Understanding and Judgment*

Lonergan proposes an articulation of the learning process in three levels (Lonergan 1990; for a synthetic introduction to the model, see Lonergan 1998), as sketched in Figure 0.1.

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<sup>3</sup> Although poorly referenced in the field of Psychology and Instructional Design, Lonergan is widely known in his proper scientific community, Philosophy. "Bernard J.F. Lonergan, S.J. (1904-1984) was born December 17, 1904 in Buckingham, Quebec, the first child of Josephine Wood and Gerald Lonergan, a civil engineer. At the age of 14 he left home to board at Loyola High School in Montreal and at 18 entered the Jesuit novitiate at Guelph, Ontario. His studies of Philosophy, Classics, Economics and Theology took him from Montreal to London to France to Rome where he completed his doctoral work and returned to teach in Canada for more than ten years. From 1953 to 1965 he taught Theology – in Latin – to seminarians at the Gregorian University in Rome. In 1965 because of serious illness, he returned to North America for good and he continued writing and teaching in Canada and the United States. He spent his last teaching days at Boston College where he was in the process of re-writing a manuscript on Economic Theory when his final illness came. As his mental powers began to fade, Lonergan returned to the Jesuit House at Pickering, Ontario, where he died on November 26, 1984. Lonergan is recognized as a philosopher-theologian who asked radical questions about the philosophical underpinnings of doing and teaching Theology. There are now nine Lonergan research centers throughout the world from Australia to Ireland to Canada and the United States. The University of Toronto Press is currently publishing a twenty-two volume series of his collected works. More than two hundred doctoral dissertations on his work are recorded in the catalogues at the Lonergan Research Centre, Toronto" (short biography courtesy of M.T. Carley). For a complete list of Lonergan's work, see Appendix A.



Figure 0.1 - The three levels of the learning process

Our drive to know proceeds from our personal experience: we want to know as we express wonder in the form of questions about the objects and situations we come across and we live by, and these questions are the primary sparkle of knowledge. The part of reality concerned by our experience is presented to us as empirical presentation, i.e. as sensations and perceptions. The level of Experience considers in fact objects of perception. As for the other levels, details are in the following pages. An author who focused his interest for education on experience is John Dewey. His theory and practice, embodied in his method and his schools, are in fact pivoted by the idea that schools should provide situations of real experience, as opposed by the instructional method that proposed notions as basis for learning<sup>4</sup>.

The point that Lonergan emphasizes – and this might be a potential critique to Dewey’s position – is that experience is necessary in order to make a learning experience more than *flatus vocis*, but it is not all that we need. Experience is not fulfilled and does not generate knowledge without the sparkle of human intelligence, which originates as a question in the framework of a culture.

The second step in learning is understanding, which means discovering the intelligible pattern in the image of the object. As analogy, it is the work of the detective and of the scientist, who see a situation – a murder or a natural phenomenon – and try to select the relevant features in order to build a complete model, a unitary vision of its causes that can explain it completely. The level of understanding considers thought objects as proper entities. Gardner and other constructivists are the scholars who most inquired the idea of understanding and that focused their theory on personal activity (as condition of experience) and mental modeling (see e.g. Gardner 1991).

It should be noted that a strict constructivist approach is difficultly viable for instruction, due to its intrinsic relativistic view. How can a teacher evaluate students if knowledge is a completely personal matter? How can any school program or curriculum be justified if there is no truth or tradition to transmit? Yet the main idea – learning is an activity – is extremely powerful and gives back the central role to the learners. But once more Lonergan goes one step further: understanding and conceptualization require a higher process, namely judgment. Notice that the remark is not prescriptive (you must judge), rather descriptive (we judge, anyway): every time we learn something, we attach a value to it, we say it is more or less worth learning and believing.

The process of knowledge therefore considers a third level, namely the level of judgment, in which objects of thought are transformed into objects of knowledge. This happens through the act of judging, or assenting: recognizing that a certain understanding of a situation, or a certain fact *is true*

<sup>4</sup> For an account of Dewey’s school idea and experience see (Dewey 1900) and (Dewey 1902). For a more theoretical analysis of experience, see (Dewey 1938) and (Dewey 1958).

and corresponds to reality – this is the moment in which the critical function plays its essential role. Making a judgment means recognizing that the evidence is sufficient to say *yes* or *no* to what we have learnt. This creates then room for self-commitment and change in behavior.

The process of learning through the three levels<sup>5</sup> of experience, understanding and judgment can be detailed by analyzing more finely the activities in progress at each level. Figure 0.2 shows this level of detail.

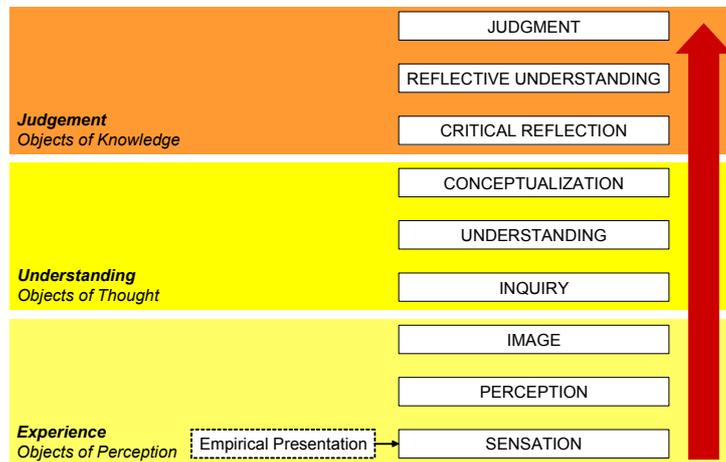


Figure 0.2 - The activities in progress at each level in the learning process

### *The Level of Experience*

To our perception, reality is an unlimited amount of data, just like those that you are experiencing by reading this text. Data means all perceptible elements: writing and pictures caught through sight as well as smells and heat variations. The senses are like open doors, like the windows of a submarine (Busa 2000), gathering information as sensations.

Data is what can be owned, possessed and transmitted, once they have been represented somehow, as ink on paper or as electrical impulses in a machine or on a magnetic support. Data in themselves do not constitute knowledge, and not even perception, but they are the first and necessary step in a cognitive path.

Sensations are filtered by perception, i.e. the active process of considering sensations as input. Perception is active, i.e. sensations are not a transparent flow of reality into our brain. Our previous knowledge, our conceptions and misconceptions, our expectations and fears influence our perception and our primary contact with reality – see e.g. the famous research of New Look in (Bruner & Goodman 1947) and (Bruner & Goodman 1949).

Despite active, perception is not consciously controlled, i.e. it cannot be voluntarily directed and shaped. We perceive what we perceive according to the influences stated above; we can be trained in order to have correct conceptions and to direct our attention to relevant elements, but we cannot control perception in itself. This is what happens almost *in vitro* with optical tricks (Figure 0.3): we perceive that the two horizontal lines in box A are of different length; actually, they have the same length, but the arrows disguise it. The two dotted lines in box B help our perception so that we know that the two lines have the same length – still, we perceive them as different if we look again at box A.

<sup>5</sup> Lonergan also connects the three levels to the three steps of classical Metaphysics (Lonergan 1990, lecture VIII): *potentia* for the level of experience, *forma* for that of understanding, and *actus* for that of judgment. The last part of *Understanding and Being* is devoted to the reconstruction of Metaphysics from the understanding process.

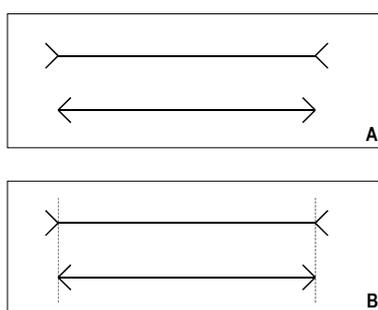


Figure 0.3 - An optical trick

The perception of data gathered through our senses is actively organized in our minds as an image (or *phantasm*) thanks to the basic cognitive principles such as thing, content/container, actor/object, etc. This is our way to represent the object of our experience to our inner flow of consciousness, and is the starting point for understanding. The generation of a correct mental image is one of the main concerns for the teacher

### *The Level of Understanding*

If you are interested in typesets and at the same time not an expert, you may be interested in learning that the typeface used for this text is called Garamond. But for the most of the readers, this data is not relevant: not all data are interesting and relevant to all subjects. It is the first rule of communication: not all data is information. In order to be information, raw data have to be interesting, they must “have to do” with the perceiver, they must represent a value in a given situation. That Switzerland has 26 Cantons, that are actually 23 plus 3 half-cantons, is not relevant to you, unless, say, you have decided to move to a Swiss city in the next month or you have decided to study the political history of the first modern democracy and the most complex European country. Data can have direct informative value if they answer to a specific information need; or indirect if they concern some other interesting aspect of reality, like a relative or other beloved person.

Data are filtered and selected according to personal criteria of *relevance*. Relevance is what draws our attention, what directs our flow of consciousness to that specific object<sup>6</sup>. Perception itself is relevance-structured, but even more is the next step, i.e. the beginning of an inquiry, the formulation of questions about the object. Inquiry is in fact defined as what can be built on the empirical presentation, and is the first step of the understanding<sup>7</sup>.

The questions formed in the inquiry can be of several types. We perceive a phenomenon and we can ask “Why?”, “What is it?”, or “How often?” Understanding is the process through which we answer a first set of questions of the kind “What is it?”

Understanding, or *insight*, means to recognize necessity or the must in the object, or to grasp it “as it is”. Let us imagine a child has to learn what a hexagon is<sup>8</sup>, and the teacher shows him<sup>9</sup> a drawing of an orange hexagon with a red contour. Then the child is helped drawing a second shape just with a red line – and here he understands, or can understand the situation: a hexagon is a planar closed shape with six sides (or six angles). Notice that the proper expression is not a condition for understanding a concept. Understanding is not the formation of a concept, but is the comprehension of the instance

<sup>6</sup> Scientific observation is not without relevance filters: they are defined in hypothesis and observation methods and tools.

<sup>7</sup> In the *Halifax Lectures* as in *Insight*, Lonergan provides implicit (or relational) definitions of the core terms used for the “understanding of understanding” he proposes. Inquiry is what comes from the empirical presentation, and the empirical presentation is the whole set of perceived data, structured in a mental image, that is the basis for the inquiry. *Self-appropriation*, i.e. the attention “of oneself to oneself”, to the inner movements of consciousness in learning, is the experience required for providing positive meaning to the relational definitions given in the text.

<sup>8</sup> The example is adapted from (Lonergan 1957).

<sup>9</sup> Notice that in all examples in which a pronoun indicates a single person and not an indefinite subject, either the masculine or feminine form has been consistently used. The generic s/he form was used in all other instances.

situation, the moment in which we feel we are grasping the situation, like a *click* in the mind. Understanding is similar to the sudden comprehension of meaning in communication. The act of understanding is active – teaching also means stimulating and fostering this process. We can also define *reverse understanding* as the understanding that some questions are not relevant for our situation, and we understand that we do not need to inquire them. This is of course highly relevant in scientific research, where the selection of the right question is a fundamental concern. The idea of insight as such is not peculiar of Lonergeran, who actually provides an original and powerful definition of it, and can be found in several authors of the Gestalt tradition. A synthetic presentation of their work is provided by Gagné, one of the fathers of Instructional Design repeatedly quoted in this work.

*As conceived in their views, learning typically takes the form of an insight, which is a suddenly occurring reorganization of the field of experience, as when one 'has a new idea' or 'discovers the solution to a problem'.*

(Gagné 1985, p.11)

Gagné accurately notes that this explains only a part of human knowledge and leaves out much of our daily learning experience, such as learning a telephone number, or the memorization of lists such as all the rivers in our region, etc. Nevertheless understanding is the core event in human learning. It is not the only type of learning, but so to say the prior one: memorization and reflex learning are functional to understanding and making sense, getting a meaning out of our experience<sup>10</sup>. The formation of a concept, or conceptualization, is the next step: a generalization and a formulation of the understanding.

*When we move to conception or formulation, the matter is more complex, since we form concepts in many ways (...). By your insight into the image you are able to formulate the conditions, the elements in the image, necessary to having the insight.*

(Lonergeran 1990, p. 165)

A concept is formed as soon as we think of the general case of which our specific object is an instance, like when proceeding from the understanding of a hexagon to its definition, which covers all the possible cases.

In Web design, it is the difference between a good solution to the commissioner's problem – the right idea – and a sound model, with definitions and procedures, for developing Web sites. It is likely that a good intuitive designer can propose a portal-like design, or a collection-like design even without having a clear conceptualization of the distinction between portal and collection in general. Of course, concepts are a great help in having correct understanding, but are yet one step further in the learning process. In a more familiar context, it is the difference between a person able to cook a good *risotto*, and another one who can explain you why it tastes so good, and can correctly formulate the recipe.

Notice that while concepts are fundamental in science, they are not the main element in common sense, where an adequate understanding of the instance situation is often the only requirement. According to the kind of knowledge considered, they play quite a different role.

Concepts can be critically thought only by means of a language, exactly as linguistic expression is a powerful tool for helping students in shaping their own concepts: teaching is in fact a matter of communication (although not always verbal). From this point of view, language can be considered as a set of formulated inquiries and insights that we receive from our tradition, and that each person can critically acquire, and freely use, extend, redefine and re-negotiate with her/his community (Cantoni 1993).

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<sup>10</sup> The hidden connection between a theory of understanding as Lonergeran's and Gagné's model of learning can be found in Gagné's idea of semantic encoding, intended as making sense, and which is "a door to long-term memory".

### *The Level of Judgment*

The main novelty of Lonergan's approach is indeed the explicit introduction of a third level in the cognitional process, where formulations and concepts (objects of thought) are transformed into objects of knowledge. It is the most critical and delicate step in the process of learning.

After experience has been understood in the instance situation (insight), and concepts have eventually been formed as a formulation of the general case, we are still restless, and a new kind of question arises: "Is it really so?", "Is it true?" Critical reflection is the act through which we turn to our conceptualization or understanding and we ask ourselves about its adequacy to experience.

How do we answer the questions raised at this level? The answer to such a question is an insight in our formulation. The method is reflexive understanding: gathering evidence that our understanding and our concepts *work* or fit the knowledge object. For example, when we have a new machine or software application, by using it we get an understanding (a mental model) of it. Does it correspond to how it actually operates? Using the application according to our understanding and seeing if it works is the way to check it out<sup>11</sup>.

*Gathering evidence* means to verify operatively that the conditions for the actualization of our object of thought are given. We in fact recognize that any state of reality is conditioned, and understanding too: if its conditions are verified, it is possible. Reflexive understanding means moving backwards until we find some (virtually) unconditioned, i.e. some verified fact or previously verified understanding or concept, that supports the appropriateness of our understanding.

*(...) A prospective judgment is virtually unconditioned when the evidence for its affirmation is sufficient: no further relevant questions about it remain. It is virtually unconditioned because it has conditions [of existence] that have been fulfilled.*

(Taken from *A Glossary of Lonergan's Terms*, Lonergan Website 2002)

This delicate detail may become clearer through an example<sup>12</sup>. A man goes out in the morning, and when he comes back finds his windows broken, some smoke inside the room and a terrible smell. Given the situation, he comes to an understanding and says "something has happened" – the state of the house has changed, so an event has occurred. He can think further: "somebody entered my house, stole my things and lit a fire". This is a possible understanding of the situation; but is that true? A confirmation can come only from the gathering of evidence. If the man sees some footsteps inside the house, which do not correspond with his own (he lives alone), he can go a little bit further in the reflexive analysis: the footsteps prove without conditions that someone has been there. The story could go further, but this is probably enough to get the point.

Judgment is the act by which we recognize and affirm the adequacy of our understanding and conceptualization to the situation or the type of situation encountered in our experience. Judgments are of different types according to their objects: they can be formulated on facts, insights into instance situations, generalizations or concepts, mathematical theories, common sense activities or scientific discoveries.

Moreover, judgments of any type can affirm truth at different levels, from complete certainty (as judging the fact that you are now reading) to all hues of probability. The acquisition of certainty depends of course on the psychological aptitude of the learner, who can also dismiss the request of judgment and not take the risk of commitment. Judging in fact involves freedom and morality, and it is necessary in order to get the learner to change and commit to what is learnt. None will judge if he does not want to; on the other hand, one is responsible for her/his judgments.

*"Judgment is the responsibility of the one that judges. It is a personal commitment. (Judgment) involves a personal commitment. (...). (Judgment) can be answered assertorically or modally, with*

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<sup>11</sup> Lonergan claims that also in common sense, ideas work when they are true: "Despite its practicality, common sense is convinced that ideas work only if they are true" (Lonergan 1957, p. 293).

<sup>12</sup> Lonergan's explanation of *evidence* and of the *unconditioned* is actually more complex and goes much more in depth. It is in fact central for a philosophical work. The example introduced here should supply the less accurate explanation reported in this work.

*certitude or only probability, the questions as presented can be dismissed, distinctions introduced, and new questions substituted.”*

(Lonergan 1957, p. 272 ff.)

No repetition or rehearsal will help – a judgment is a matter of personal comparison between the learner’s understanding and experience. While it is always possible to acquire an understanding or a set of concepts from a book or a teacher, judgment is a strictly personal and individual activity, which can hardly be supported (or manipulated) by an instructor.

### *Learning as a Dynamic*

It is clear that the differentiation between levels proposed in the previous pages is an abstraction aimed at understanding and conceptualizing the complex phenomenon of learning. Learning proceeds simultaneously bottom-up (from perception to judgments) as presented, and top-down, from knowledge and concepts to understanding. More perceptions, and the relationships among them, can allow the identification of more relevant facts, i.e. information. On the other side, the concepts and previous knowledge influence our perception and understanding. The more we are interested and have a lively and deep relationship with an object, the more we will be able to improve our knowledge of it. That’s why your technology-addict friend always gets the idea of what the best choice in computers is much faster than you do. Figure 0.4 represents the three layers involved in the dynamic process.

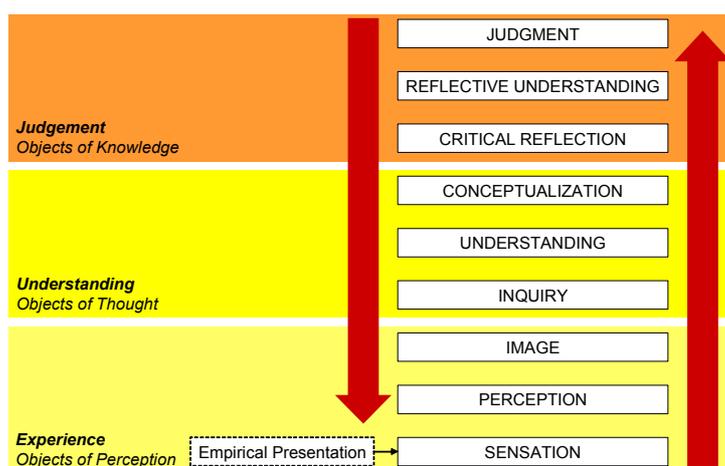


Figure 0.4 - A representation of the learning process as dynamic

This two-way dynamic is supported by hypotheses making and by the definition of an ideal of knowledge (Lonergan 1990). The top-down arrow in fact consists mainly in defining a hypothetical arrival point for the pursued knowledge, which serves as a grade for the whole process. It is a mere representation of something we do not know – hypothetical indeed – and this exactly its value: it is a name, like the  $x$  in mathematical expressions. One of the main challenges in teaching is offering a reasonable, understandable and fascinating  $x$  to chase in learning.

### *An Example from Continuing Education*

Continuing education in Information Technologies can be a suitable field for an example of this dynamic. As a consultant, the author was once asked to organize a set of activities for providing a basic introduction to office automation applications to twenty (in two groups of ten) employees in a

public regional institution<sup>13</sup>. The management expressed the expected outcome simply as “they should be able to use that stuff”.

A first analysis of the problem and some interviews with the future attendees revealed that all of them already used office automation daily, but only for specific tasks. They were unable to solve any unexpected event (e.g. a failure or a network problem) or to think out a computer-supported solution for a new kind of operations. The general learning goal was then formulated as letting them understand what they already did as basis for a more competent and flexible use of office applications. In Lonergan’s terms, all of them had had a huge *experience* of applications, but had no correct *understanding* of them – they could not figure out what was happening in any unexpected situation. In other words, they knew paths into the applications, but had no comprehensive map of the whole system. This was probably due to the lack of time in acquiring IT competences: under the pressure of daily task, they had had not time for a true *inquiry* of the system, thus asking “How does this work?”, but just “How do I do this in the least possible time?”

The choice made was to devote a part of the course to setting the right questions for the inquiry. The observation of common operations was used as occasion for focusing the “What is happening” question, and thus looking for signals of the application status (e.g. the status bar in many common applications). The understanding of the situation was fostered initiating the top-down dynamic of learning, i.e. by providing “hypothetical” concepts (digital information, RAM, CPU, etc...) that were used for modeling the machine’s operations, and to understand what should be fixed in cases of failure. This conceptualization also helped making practical sessions more transparent: experience had become source of understanding, thanks to concepts that could enlighten it.

## **Tenet 2: Teaching as Art**

While learning is an intentional activity, teaching can be assimilated to painting or playing. These skills can be acquired, and experience enhances the performance, but a good teacher, like the painter, the musician or the doctor, is natural born. The closest example is probably rhetoric: anyone can improve its ability for public speech through a number of exercises, but a good speaker has an added value.

Painting, playing an instrument and talk to a public are arts, i.e. practices supported by specific knowledge (Cantoni 1996). As such, learning and practicing can improve them, but only if rooted in the fertile soil of natural aptitude.

But if we can hope to have (or to be) naturally talented teachers, what can be learnt? Specific knowledge (the steps for composing a good speech), examples of best practices and common mistakes (the *autores*), tools that improve the performance (a specific voice intonation, eye contact tricks, etc.).

The topic addressed in this research work, as it will be presented hereafter, belongs to the tools that the educational designer can use for improving her/his performance.

## **Tenet 3: Models as Tools for Practice**

Instructional Design as a discipline has produced several models in order to help the designers in their not easy task. This work is focused on the development of a language that can integrate those models. An interesting discussion in the field focuses on the theoretical foundations behind each model, which of course are of different nature, as the researchers in this lively field belong to different traditions.

Nevertheless models differ from theories, as they are *tools* for practice, and not a synthesis of a particular educational philosophy. Of course, each model, as each tool, bears the “genetic traces” of the cultural and theoretical environment that generated it, as each artifact encodes the meaning that its creator gave to the considered situation, task or activity. But its usage and the final outcome (as pointed out above) depend on the interaction between the actors, the environment and the tool, and not only on the tool itself. One example of that can be taken from the evolution of Instructional Design models. A great part of them come from the Sixties and have a behaviorist approach.

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<sup>13</sup> The example dates back to October-November 2001.

Nevertheless, in the last decade, they have been reinterpreted from a constructivist perspective and reframed into a new conceptual paradigm. Learning and instructional theories can also be interpreted as models.

This work rests on the belief of freedom in the use of models, and the proposal contained here should be evaluated from this perspective, in relation to its actual usefulness and adequacy to the problems it is designed for.

#### **Tenet 4: Continuity between Technology-based and Classroom Education**

The issues raised in these pages, which form the context of this work, are mainly bound to the introduction of new media in education. Teaching with technology requires a more complex and structured design and development activity that may benefit from a representation language.

Nevertheless, I argue that a great part of those issues also concern other instructional settings, namely more usual ones. The definition of learning outcomes, the consistency of the learning activities with one another and with the learning goals, the suitability of learning materials to the activities and to the educational environment, the definition of roles, etc., are all elements that should be taken care of in any educational situation. Berge & Meyers (2000) agree with (Clark 1999) in claiming “there is little if any difference pedagogically between online and offline instructional design”. Education, teaching and learning, remain the same despite any means used, and the main pedagogical elements are unchanged. But the design process achieving a successful learning experience should be revised in order to meet the challenges of the increased complexity.

There is indeed a continuum, within which the different forms of education are located. Different tools and models for the design of education can be used in several situations, maybe adapting or revising them. E<sup>2</sup>ML is one of those tools, conceived for complex design projects, but also potentially useful in other situations. Nevertheless, in order to keep the focus, these situations will be only hinted at in these pages.

#### **Working Hypothesis: Design as a Critical Factor for Education**

So far the research context was outlined with some issues, and four tenets were exposed. Before coming to the actual research, a last remark deserves some lines.

The activity of education grows more and more complex for a number of reasons. This complexity may spoil the quality of the educational experience for learners, as well as make the designer’s work a sophisticated kind of hell.

The working hypothesis for this research is that design is the critical factor for managing the overall complexity of educational environments. Along with existing Instructional Design models, adequate conceptual tools or theories can be developed for reducing the effort of keeping all the relevant elements fitting together, and to set up enhanced educational activities.

Does this mean that design is always necessary? Yes, although not always formal design. Design methods should be justified by the overall complexity of the system. There are instances in which formal design tools would be like using sophisticated software engineering approach for producing a letter with a word editor. Nevertheless, the principles behind Instructional Design techniques have proved to be useful also when formalisms were out of place. In the same way, I hope that this work may provide a useful mental framework for educational designers.

#### **Remarks**

This introduction has achieved its goal if it has made clear the eclectic theoretical perspective that underpins this work. The idea I tried to introduce with Lonergan is that education is a human dynamic which can be described yet never completely analyzed. Each theory – and Lonergan’s too – provides new insights, as a special magnifier glass. It helps identifying new details, but not seeing directly the

objects as a whole. Behaviourism, Cognitivism, and Constructivism, all shed some light on teaching and learning, but none grasps the whole picture that we perceive in our experience. This is why they are useful if taken as complementary tools – but the final reconstruction takes place in our minds.

Education is then a human dynamic; teaching is the risk of meeting new people, and learning is the risk of changing one's view. Both teachers and learners, at any age, should be ready to share ideas, discuss, create and resolve conflicts in order to get one step closer to the object of knowledge. This risk is what makes the whole problem interesting.

From the perspective of the designer, these remarks make clear what the role of design is: creating an environment in which people can meet, and learning can happen.

## Research Structure

### Goals

This work aims at developing E<sup>2</sup>ML – Educational Environment Modeling Language, a visual modeling language for the design of educational environments in Higher Education. The great majority of Instructional Design models describe the phases which the design team should go through in developing a course in the most effective and efficient way. This work's goal instead, is creating a tool for representing the product of the design process: the educational activity, or the activities performed into an educational environment.

As a comparison, think of architecture in the XX century: up to the '90s, all studios knew that in order to build a building they had to provide different blueprints and elevations to the committers, and technical plans to the builders. Then came 3D visualizations, as a new language that architects could use for showing their ideas to the committers, thus overcoming the difficulty they had in imagining the real space out of colorless 2D plans, and eventually to other professionals, in charge for example of furnishing. Although in a different context, E<sup>2</sup>ML is a similar tool: a language for expressing instructional activities that can be used in different communication settings.

As conceptual framework, E<sup>2</sup>ML is composed by an explicit definition of the learning process and of the educational activities; as a formal visual modeling language, it defines a visual syntax. In particular, it addresses the following issues:

1. Visualization for design
  - a. The subject of educational design is an interdisciplinary team, as mentioned above. E<sup>2</sup>ML can *ease and enhance communication* in the design team and with external partners.
  - b. The definition of requirements for the tools and materials that support teaching and learning is a delicate issue, and it often concerns great investments, both in the case of off-the-shelf solutions and in that of custom development. E<sup>2</sup>ML is a tool for systematically defining and *expressing the educational requirements* of software applications.
  - c. Setting up an educational environment is great economic effort, and should be balanced by an adequate return on investment. E<sup>2</sup>ML can support *static quality assessment* through the expression of formal features, e.g. consistency. This can help controlling the quality of the educational environment at design time and distinguishing quality-critical applications or content from optional nice-to-have features, and optimizing investments.
  - d. E<sup>2</sup>ML representation of the designed educational activity could be the basis for a *project management approach* to course development.
2. Design documentation
  - a. Representing an educational activity with E<sup>2</sup>ML means *producing a documentation* that can be archived, thus creating a historical archive of the design community.
  - b. Documented projects, or parts of them, could be eventually *reused* for new projects.
  - c. The design documentation of courses can be used for *training novice designers*.
3. Reverse engineering and evaluation

- a. Given the complexity of educational environments and the uniqueness of each class and of each learner, unexpected learning outcomes may rise. E<sup>2</sup>ML may be used as a *diagnostic tool* for identifying relevant issues and for figuring out viable redesign solutions.
- b. Documentation of past designs can be used for *evaluating a course ex-post* (together with learners' feedback and other elements)
- c. Documenting a course makes it more *accountable*.

## Research Path

A short notice should be made about the relatively winding and interdisciplinary path that led the author to this kind of research.

The first idea was actually creating a methodology, or a set of principles, for the effective and efficient exploitation of Adaptive Hypermedia Systems (AHS) in eLearning. A first approach to the problem showed that the step before was missing: no sound general model existed about the integration of technologies *tout-court* in education. With no solid ground on which to build, what could be expected from a research on such a particular kind of system such as AHS<sup>14</sup>?

The focus was then moved to eLearning as such, and on the integration of technologies in education. The problem was articulated with the definition of EE as research object, and with the confirmation of the particular perspective on design. This placed the work in a new context, that of Instructional Design. From the confrontation with this discipline, cross-fertilized with elements from the world of technologies, comes E<sup>2</sup>ML.

A last element was introduced by the necessity of a person with an education curriculum focused on communication and communication technologies to acquire a precise view on education. This pushed the research for several months in the field of Educational Psychology. The result may be well summarized by this statement from (Dick & Carey 1996):

*Educational psychologists have conducted much research over the past seventy years to determine how people learn. If you have read any of their research, then you may feel that it often seems esoteric and generally removed from real-life situations. Psychologists have been successful, however, in identifying several major components in the learning process that, when present, almost always facilitate learning. Three of these components are motivation, prerequisite and subordinate skills, and practice and feedback.*

(Dick & Carey 1996, p. 184)

Indeed, a lot of research in Education Psychology may be helpful in drawing hypothesis about what happen when we learn – given the fact that we do learn! – but often leaves open the issue of how to provide effective instruction.

The path moved then forward to Educational Philosophy: in order to provide a good *something*, you first need a definition of the basic element of that *something*. While the basic assumptions gained have been presented above in the tenets, the result of this phase of the work will not bother you explicitly here.

## Text Structure

This work is structured in five Chapters. Chapter I presents a State of the Art in Instructional Design and Education modeling. E<sup>2</sup>ML is presented and discussed in Chapter II. After a general introduction, the basic syntax and semantic are defined and illustrated by examples. Chapter III discusses E<sup>2</sup>ML and

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<sup>14</sup> This statement, and the consequential redefinition of the research objective, was made in 2000. In the last years, with the definition of Learning Object metadata standards and the specification of different eLearning practices, the situation has actually evolved (see Armani & Botturi 2003).

compares it to other Instructional Design models, in order to show how it can be integrated in the current practice, and in some future trends. Case studies are presented in Chapter IV, in order to provide real examples of use of the language and to proof its expressive power. Each case study is a course in the context of an academic institution. Along with the case studies, the possibility to express pedagogical patterns with E<sup>2</sup>ML is explored. Chapter V finally provides some elements for a preliminary evaluation of E<sup>2</sup>ML. The Conclusion wraps up the whole work and indicates outlooks.



## CHAPTER I

# AN OVERVIEW OF THE DESIGN OF EDUCATION

*"Instruction is a human undertaking whose purpose is to help people learn. Although learning may happen without any instruction, the efforts of instruction on learning are often beneficial and easy to observe. When it is designed to accomplish a particular goal of learning, it may or may not be successful (...) in the sense of aiding learning."*

*"Lesson design partakes of art as well as science."*

*(Gagné 1992, p.3 and 251)*

Chapter I is devoted to some of the most referenced Instructional Design models, according to the classification proposed in (Gustafson & Branch 1991). The goal of this review is not to offer an exhaustive summary of the discipline, but to provide the necessary elements for the development of E<sup>2</sup>ML. More exhaustive summaries can be found in (Gustafson & Branch 1991; 1997) and (Reigeluth 1983).

The following pages will consequently focus on the main areas and provide the necessary references. Each of the selected models is introduced as illustrative example of a broader category. Technological standards for the description of learning objects and activities are also part of this review, as they represent a new interesting trend from the IT field.

According to its goals, this chapter does not provide an historical perspective on Instructional Design<sup>1</sup>. This would be very interesting exploring the history of ideas, as the development of design models is indeed always strictly related with the development of concepts, in this case with the evolution of the ideas of education, culture, knowledge and school. The re-contextualization of existing models into a new conceptual framework is another interesting and always ongoing process in this discipline.

## What is Instructional Design?

The term Instructional Design was introduced at the opening of this work with Smith & Ragan's the definition:

*... The systematic and reflective process of translating principles of learning and instruction into plans for instructional materials, activities, information resources and evaluation.*

(Ragan & Smith 1999, p. 2)

This definition expresses in a clear manner the relationship between design and principles. Nevertheless, it does not include, at least explicitly, the three elements or sub-disciplines in which Instructional Design is classically organized, and that will be introduced and discussed below. Other more practice-oriented definitions are the following:

*Instructional Design is the process through which an educator determines the best teaching methods for specific learners in a specific context, attempting to obtain a specific goal.*

(IEEE 2001, p.1)

Or:

*The systematic method of implementing the instructional design process is termed Instructional Design. We (...) see Instructional Design as the process for designing instruction based on sound principles.*

(Morrison, Ross & Kemp 2003, p.5/6)

The IEEE definition gives relevance to the elements involved in design: an educator (in our terms, the educational designer), the learners, the context and the goal. All these elements are *specific*: Instructional Design does not produce general solutions; it is a set of methods and tools for achieving

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<sup>1</sup> A red-thread for such analysis could be found in (Gustafson & Branch 1997). An interesting document for an historical approach to Instructional Design is (Gagné 1987). In this short communication, Gagné makes some considerations on the professional profile of the instructional designer.

particular instructional solutions in particular cases. Morrison, Ross & Kemp provide another hint: Instructional Design is a design process for specific “products”, namely instructional activities, based on sound principles. The request for soundness confirms once more the connection to learning theories stated by Smith and Ragan. And at the same time, it shows the relevance of other fields, such as project management or team communication.

These elements are enough to proceed in the analysis. A more extensive and detailed discussion of the nature and structure of Instructional Design can be found in (Reigeluth 1993).

### **What are Instructional Design Models? A Stress on Method**

Instructional Design models are the main tools for designers.

*Instructional development models are almost as numerous as the practitioners of instructional development. The role of models in instructional development is to provide conceptual and communication tools that can be used to visualize, direct and manage processes for generating episodes of guided learning.*

(Gustafson & Branch 1997, p.73)

The main thing to understand is that Instructional Design models (that Gustafson and Branch called instructional development models) are models *of the design process itself*.

This is a peculiar feature of this discipline. Several models in use in other disciplines are models *of the object of the discipline*, and not of a process. Hypermedia design models represent the hypermedia product of the design process; an architect calls a model of design a particular typology of buildings; Physicists model the particles they study; instructional designers use models that describe not the object of the design but the design process that should be undergone for increasing the chances to produce high-quality instruction.

Instructional Design is therefore concerned with the quality of instruction, but its question is not “What is good instruction?” (which is partially answered by learning and instructional theories), rather “How do we design good instruction?”. The answer to the latter question is more practice-oriented, and clearly depends on the answer to the former one – yet the main stress remains on the “how to”.

The cause for this particular approach is surely historical, but also corresponds to the fact that the process of instructional design

*(...) Is not necessarily linear and may be quite dynamic, recursive and never ending.*

(Gustafson & Branch 1997, p. 73)

The stress on method is therefore a particular feature of Instructional Design. This may also be related to the great complexity of this particular case of design. Its main features can be summarized in the following points:

1. The instructional designer is not working on a physical object (a building, a dress), but on a set of interactions. The educational environment, which is the (at least partially) tangible output of the design process, is a set of possible interactions, not a system with definite predictable outcomes.
2. The instructional designer’s goal is a mental process, namely learning, which is neither measurable nor predictable.
3. To the further increase of complexity, no unique definition of learning or interaction is available.

One may say that features 1 and 2 also belong to any product of design: the architect does not know how the inhabitants will use a building. All the same, the building is as it is. This is not true for a learning environment, as interactions are its core, and they largely depend on the persons involved. It

is a common experience of any teacher that the same learning activity has different outcomes with different classes – this is the real challenge.

The virtual space of Instructional Design can be defined with three axes:

1. Three more specific sub-disciplines.
2. Three layers on which the design process is articulated.
3. The scope of models.

### Three Sub-Disciplines

Instructional Design is a multidisciplinary problem-solving practice, and the following three sub-disciplines form its core structure.

#### *Instructional Design*

The first element or sub-discipline is instructional design, which gives the name to the discipline itself, and that is its core part<sup>2</sup>. Instructional design is the pure design process, i.e. the conception of the educational activity as a solution to a particular problem. The very nature of instructional design, as of any design, is concerned with instances and real situations, and is aimed at solving specific problems. Design is a dynamic among conditions and constraints, desired outcomes and methods for achieving them (Reigeluth 1983). By educational activity, at this level, it is understood the educational environment as a whole (i.e. its holistic principle) and of its parts in terms of functions and interrelationships. The output of the activity of instructional design is therefore a plan, or a specification of a project, and *not* a product, nor a set of activities on the run. The conception of the educational activity happens in fact virtually in the mind before than *in rebus*.

#### *Instructional System Development*

The educational activity plan produced by instructional design must then be implemented as a real educational environment: each element must be produced, the persons involved trained in order to accomplish their role in the interaction, the locations set-up. These activities are gathered under the name of instructional system development, the second sub-discipline of Instructional Design. The focus of instructional system development is narrower in scope: it does not address the overall holistic principle, or the general educational strategy, but takes on the functional definitions provided by instructional design in order to implement them. While creativity and analysis are the key competences for instructional design, here the stress is on precision and efficiency in production. The output of the instructional system development activity is a ready-to-go educational environment, with all components implemented and people ready: books, hard copy or digital materials, software applications, classrooms, trained tutors, etc.

#### *Learning Theories*

The last element in the structure of Instructional Design is the one underlined by Ragan and Smith's definition, "principles of learning and instruction". The conception of educational activities and the development of an educational environment need to be guided by some general principle reflecting the designer's or educator's idea of teaching and learning. It is impossible to take advantage of Instructional Design methodologies and tools without an understanding of what education is – what teaching means and how learning happens –, just like no cookbook can help you preparing a tasteful dinner if you do not have an idea of what a tasteful dinner is. On the other hand, each method and each tool was developed with a specific idea of education. This generates the dynamic between the designer and the tools s/he can use, like the painter with the rules and conventions of his time. Of course, if the creator's idea would be harmonic with mine, it would be easier to integrate the tool in my own design process – but it is not a necessary condition. What is necessary is a critical

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<sup>2</sup> For avoiding ambiguities, we will refer to the discipline as Instructional Design (uppercase), while instructional design (lowercase) will refer to the particular activity and sub-discipline.

comprehension of the origin of tools, so that a tool is not simply *taken* but can be *chosen*. The more a designer is skilled and has a precise and critical idea of education, the more s/he will freely select and finally re-shape Instructional Design tools and methods, in the same way as Picasso assimilated other painter's techniques and sensibility to reinterpret them in his own way.

In short, Instructional Design can be considered a problem-solving activity that involves different disciplines. Instructional design, instructional system development and learning theories form its core. Along with the ones presented above, project management, team communication and some technological skills are also necessary. Reigeluth specifies also this more practical side of Instructional Design indicating that instruction requires five major activities (Reigeluth 1983), each of which is like a coin with two sides: practice and research:

1. Design: developing the "architect's blueprint".
2. Development: defining the details and preparing the materials.
3. Implementation: realizing one edition of the instruction in an instance situation.
4. Management: managing the instruction, "letting the building work".
5. Evaluation: assessing the value of the instruction.

Reigeluth then focuses on the design activity and describes it with a crystal-clear definition, reported as major milestone in this work:

*Instructional design is concerned with understanding, improving and applying methods of instruction. As a professional activity (...) it is the process of deciding what methods of instruction are best for bringing about desired changes in students knowledge and skills for specific course content and a specific student population. The result of instructional design as a professional activity is an architect's blueprint for what the instruction should be like (...). On the other side of the coin, instructional design as discipline is concerned with producing knowledge about optimal blueprints.*

(Reigeluth 1983, p.7)

An even more detailed approach to the disciplines involved in the practice of instructional design can be found in (Richey, Fields & Foxon 2001).

### **Three Layers**

J.C. Richards and T.S. Rodgers (1982), in a paper concerned with second language learning, claimed that a teaching method for second language learning could be organized on three layers: approach, design and procedure<sup>3</sup>. These layers provide a second dimension to our grid for the description of Instructional Design models.

#### *Approach*

Richards and Rodgers define *approach* as referring "to theories about the nature of language and language learning that serve as the source of practices and principles in language teaching". The first and most high-level layer considers the overall rationale of the instruction, specified as beliefs about the epistemological nature of the subject, and the nature of learning. A statement on this layer could be "software programming is a competence that requires basically a lot of practice", or "Linguistics should be understood in its historical development".

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<sup>3</sup> They were reprising here a paper by E. Anthony.

### *Design*

The design level includes the actual design of the course, with the definition of specific sub-goals (or objectives) and of four main elements:

1. The content, i.e. what the instruction is about and how is it organized.
2. The teaching roles, i.e. what is expected from the instructor(s).
3. The learning roles, i.e. what is expected from the learner(s)
4. The materials, i.e. all the objects that support the educational activity.

This layer transforms the approach layer into particular design choices, and at the same time provides an input for the procedure layer. Following a particular instructional strategy, on this layer the designer can decide to foster trial-and-error learning and to realize a course Web site for accessing all course materials, or s/he can decide to leave great room for group work and discussion.

### *Procedure*

A procedure “encompasses the actual moment-to-moment techniques, practices, and behavior that operate (...) It is the level at which we describe how a method realizes its approach and design” (Richards & Rodgers 1982). The last layer concerns the in-the-small design of the pedagogical elements defined in the design layers, such as the choice of a particular setting of discussion, the definition of role-playing for group work, or the detailed specification of the course Web site.

The three layers are strongly interconnected, each of them providing the input for, or influencing, the next layer. Notice that the shift from one layer to the next is not driven by necessity nor rules: a specification on the approach level does not have bi-univocal consequences on the design level, nor it is the case between the design and procedure level. The designer interprets decisions on one layer, and is in charge of performing sensible choices in order to define those on the next one. Using a concept from Linguistics, a choice on one layer limits a paradigm of possible choices on the next level, but the selection of one element in that paradigm is up to the course designer, and depends on her/his ability and understanding of the situation. This is what makes teaching and course design more an art than an engineering process: it strongly depends on the personal capacity and free risk-taking choice of teachers and designers.

This remark should be kept in mind while going through this Chapter, as the nature and claim of several models is making the design of instruction scientific and tentatively error-free: the diagrams and methods presented will at least evoke the idea that a well-structured design process may guarantee high-quality instruction. According to the perspective presented in the Introduction, I reject this claim, recognizing that expertise and suitable tools may only improve the chances of producing the spark that will light up the mysterious wood of human curiosity to develop the fire of knowledge.

## **Three Scopes**

In order to present models in a systematic way, they will be framed into the taxonomy of Instructional Design models proposed by (Gustafson & Branch 1991) and reprised in (Gustafson & Branch 1997), as it is the more traditional within this discipline. Gustafson and Branch’s taxonomy divides models in three main groups according to a number of salient features that determine the *scope* of the model. The considered features are:

1. Typical output (or granularity). Education can be developed on different scales, from a short one-hour’s lecture or a lab experiment to a complete course or curriculum.
2. Resources committed to development. The resources available or committed to the development of instruction can be scarce or abundant. Using a structured design approach raises the chances of a high-quality product, but at the same time imposes overhead costs.
3. Team or individual effort. Some models foresee interaction among different professionals in a team, while others are tailored to the needs of a single teacher.
4. Instructional design skill or experience required. While some models are suitable to beginners, others are of greater complexity and can be profitably used only with adequate expertise.

5. Emphasis on materials development or selection. One of the great and unavoidable dilemmas in Instructional Design is: “should I develop brand-new and perfectly tailored instructional materials, or should I reuse all that I can from existing resources?” Models usually set an emphasis on one of the two ends of the dichotomy.
6. Amount of front-analysis or needs assessment. According to the typical situation for which the model was originally developed, a different amount of analysis or needs assessment is foreseen.
7. Technological complexity of the delivery media. Some models were developed also for supporting the introduction of technologies in education, and are therefore more suitable to a high degree of technological complexity.
8. Amount of tryout and revision. This feature considers the number of prototypes suggested in each model – tryouts of learning materials, but also to the testing of particular activities.
9. Amount of distribution or dissemination. After the instruction has been developed, will it be distributed into different situations, or can it be reused?

According to these features, Gustafson and Branch (1997) define three categories of Instructional Design models, which are three different perspectives from which Instructional Design models can be viewed: classroom-oriented models; product-oriented models; and system-oriented models. The specific definitions provided by Gustafson and Branch are reported in Table 1.1:

	<b>Classroom-oriented</b>	<b>Product-oriented</b>	<b>System-oriented</b>
Typical output	1 to few hours	Learning material	Course or curriculum
Resources committed	Very low	High	High
Team/individual	Individual	Team	Team
Skill and experience	Low	High	High to very high
Development / selection	Select	Develop	Develop
Analysis & needs assessment	Low	Low to medium	Very high
Technological complexity	Low	Medium to high	Medium to high
Tryout and revision	Low to medium	Very high	Medium to high
Amount of distribution	None	High	Medium to high

Table 1.1 - Taxonomy of Instructional Design models, adapted from (Gustafson & Branch 1997)

These features do not address the substance of the models, i.e. do not deal with the phases or specific methods that each model presents. Particular models fall within each category according to the assumptions behind them: who the designer is, what s/he is developing, in what circumstances. As the authors warn, Instructional Design models

*(...) can be, no doubt, used successfully under different sets of assumptions, but classifying them does have the advantage of exposing their assumptions to analysis.*

(Gustafson & Branch 1991, p.79)

The presentation in the following pages will follow Gustafson and Branch’s classification as backbone. The distinction of disciplines and layers will be used as a magnifying glass for a better understanding of particular features or relationships between models.

## Instructional Design Models

### General Design Guidelines

The spread of the Internet and of new media has produced a number of books offering guidelines for teachers, such as (Schweizer 1999) and (Mc Cormack & Jones 1997). The situation these texts address is that of a lone-ranger teacher in charge of a whole course from A to Z. They do not propose any structured design methodology, formal analysis or development tool that could be extended to a different situation. These texts usually blur the three layers, shifting from a theoretical approach to practical implementation details, and from one sub-discipline to the other.

Usually they provide guidelines and checklists, along with more or less psychological or educational insight. It is also peculiar that they address the whole design and development process to the utmost tiny detail, as the use of HTML, the production of graphics or the publishing of a Web page. The result is often clumsy, as no unifying rationale can be found, and the teacher's impression is often a high demand on her/his technical competencies. What makes these books useful is that they grasp the complexity of course design and teaching with new media, although they do not frame the design and development process into a production context, with teamwork and with division of tasks. They try to tackle the new issues with the old craftsmanship approach.

Such texts cannot be said part of Instructional Design, as their approach does not rely on sound principles or theories, but is more often a summary of the author's experience. All the same, they are worth mentioning as they represent a sort of *vulgata* of Instructional Design.

### Classroom-Oriented Models

Classroom-oriented models usually consider one person, with few resources available, in charge of designing and conducting one or few hours of instruction. This person has usually a beginner's experience in Instructional Design, and the models proposed are therefore relatively simple; namely, the analysis and needs assessment techniques proposed are quite straightforward. The emphasis is on the selection and adoption of ready-made learning materials (such as a textbook) more than on custom development. Consequently, no trial and revision process is undergone, and the technological complexity of the environment is low. Reuse is also not a central issues in these models.

Basically, classroom-oriented models are a structured approach to a standard Western school daily life, where usually all teachers are able to survive without models and without (explicit) design techniques. So, where is the point? Historically, the reflection on simple situations gave birth to simple models that have been afterwards developed into more sophisticated structures. Moreover, the power of a model, no matter how simple, is making teachers more aware of their job, thus enhancing their professional activity beyond their natural aptitude.

The general focus of classroom-oriented models is on the design activity and on the design layer, although the development activity and some indications about the procedures may be a matter of concern. The distinction between design and procedures – which is indeed naturally blurred – is not clearly assessed.

#### *ADDIE*

ADDIE is the standard basic model in Instructional Design. It is referenced in several documents proposing standard design processes, such as in (IEEE 2001) and (AskERIC 1999). Its name is an acronym for the phases a sound design activity should go through: Analyze, Design, Develop, Implement and Evaluate (see Figure 1.1)

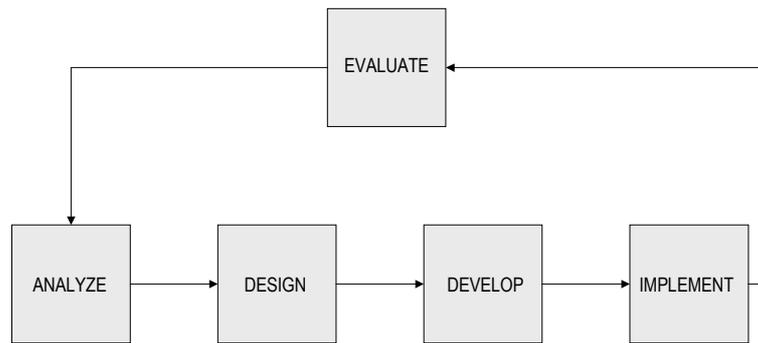


Figure 1.1 - the ADDIE model

Its simple structure reveals two important features shared by almost all models.

1. The process starts with analysis, not with design. The importance of such an activity (which in classroom-oriented may be not so relevant as in models with a wider scope) is paramount and obvious for anyone familiar with any kind of design. Nevertheless, designers often start believing that the situation is clear, while it is seldom the case. This is particularly tricky for teachers: they are used to work mostly in institutionally steady situations (schools, universities, etc.), and they perfectly master the subject matter. All the same, some elements may be still missing.
2. The design activity is cyclic. Once the course is over, the process – and the designer’s work – is not. Instructional Design stresses learning from experience, assessing results and improving over time.

The five phases are presented in the following paragraphs. ADDIE does not provide specific tools or methods for them. The stress is rather on their existence and order.

### Analyze

The analysis phase consists in collecting information about the elements of the instructional situation, namely:

1. Learning goal(s): what knowledge or skills the learners are expected to acquire with the instruction.
2. Characteristics of learners: age, previous knowledge, previous learning experience, attitude toward learning, etc.
3. The learning context: location, accessibility, facilities, time schedule, etc.

### Design

The design phase considers the content to be taught and works on its division into chunks, or sub-topics. The lesson plan should be developed according to a selected strategy, deciding what content should be presented in what form, and through what activity. The delivery media (classroom, asynchronous Web site, videoconference, VHS videotape, etc.) and learning materials are also selected in this phase. Several constraints should be taken into account: the delivery media and the learning materials are in fact often not selected, rather given by the specific situation. Moreover, the resources available to actually get everything ready should be considered: feasibility is part of design. The designer’s art is matching and rearranging the three elements of design (content, strategy and media) into an organic whole suitable to the environmental characteristic emerged in the analysis phase.

### Develop

The development phase considers the production and testing of the learning experience in all its components. This means arranging the selected materials to fit the teaching strategy, integrate them in

the activities and expositions, eventually develop new materials and finally rehearse (when possible, test) the final outcome, i.e. the educational environment.

### Implement

ADDIE defines the implementation phase as the actual enactment of the learning experience. It is interesting as in other models the learning experience is often *outside* the design process, as something that happens afterwards, and testing and review replace the implementation. The idea here is that the real educational environment is ready and used, with all the contextual variables that may influence it (the weather, the learner's mood, etc.), and its observation is the input for the next phase

### Evaluate

Evaluation is of paramount importance as it makes the model cyclic. The evaluation of an educational environment is different from the evaluation of the learners, as it concerns the instruction as such. This simple consideration means that the designer, during the previous phases, should consider that it would take place, and therefore would dispose elements for its effective execution, such as indicators for learner satisfaction (for example included in the test or as a specific wrap-up of the online forum interaction), for the achievement of learning goals, for the effectiveness of materials, etc.

Did the instruction achieve its goals? Were resources enough for it? Were learners satisfied? Were the materials suitable to the activity? These are some of the questions that should be answered. The answers should lead to a new analysis of the situations, enriched by experience, and to a review of the whole process.

It is interesting to point out that the evaluation phase may actually provide pointers for revision to all the other phases, not only to the analysis. An accurate observation of the learning experience may reveal that the learning materials could be improved, or differently selected, or that the overall strategy should be revised. The general model representation could be adjusted as in Figure 1.2:

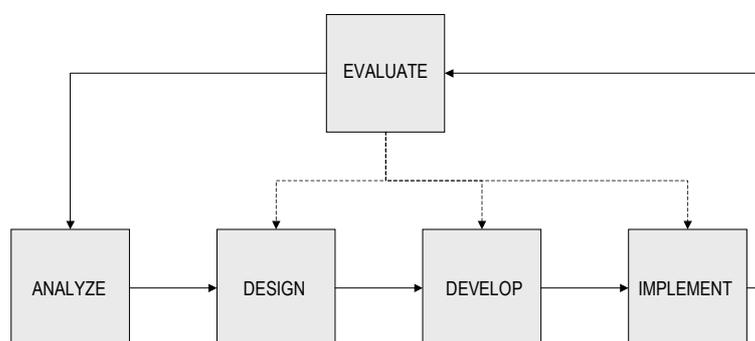


Figure 1.2 - The ADDIE model revised

The ADDIE model presents a general and generic structure for instructional design. Other models with a broader scope expand its basic structure by adding phases and providing specific techniques for each of them.

### *ASSURE*

Developed by R. Heinich, M. Molenda and J. Russell (1993), ASSURE is an evolution of ADDIE. ASSURE also presents phases, and shares with ADDIE its two main features: the initial focus on analysis and the cyclic structure. The peculiar feature of this model is that it is focused on “planning and conducting instruction that incorporates media” (Heinich, Molenda & Russell 1993, p.31) – its main perspective is the integration of media into the instruction in a proper and effective way.

ASSURE is also an acronym, and stands for:

- Analyze learners.
- State objectives.
- Selects methods, media and materials.
- Utilize media and materials.
- Require learner participation.
- Evaluate and revise.

Differently from ADDIE, ASSURE proposes specific checklists for each phase, presented in the following paragraphs.

### Analyze Learners

This first phase corresponds to ADDIE's *analyze*, but specifies the object of analysis: the learners. Heinich, Molenda and Russel propose three main categories for the analysis:

1. *General characteristics* include the number of learners, their grade, age, sex, cultural features, attitude toward the discipline as a class, etc.
2. *Specific entry competencies* concern the (expected) previous knowledge on which the current instruction can rely, such as the ability to use the Internet (a tool that can be exploited), or the knowledge of the States and Capital Cities in Europe (factual knowledge), etc.
3. *Learning styles* should also be considered, as the instruction should be valid for different preferences. As this is a central concept in the analysis of learners, I will dwell a little on it beyond the scope of the ASSURE model. Learning styles can be classified in different ways. A general outline along with the references to the main authors will suffice to get an idea about them. A general distinction considers four basic styles as sensory preferences (visual, auditory, tactile, kinesthetic). Kolb's Learning Style Inventory (1999) defines four learning styles as cognitive preferences: concrete experience, active experimentation, abstract conceptualization, and reflective observation. According to this view, each learner's learning style is a combination of the four basic styles (see Figure 1.3). Another way of interpreting the issue is through the theory of multiple intelligences proposed in (Gardner 1983). This theory claims there are seven different kinds of intelligence: verbal-linguistic, logical-mathematical, visual-spatial, musical-rhythmic, bodily-kinesthetic, interpersonal and intra-personal. A last hint on learning styles is provided by Gregorc (1979): he describes learning styles as dualities, such as associative vs. separative relationships, or deductive vs. inductive thinking modes. Gregorc then proposed a more detailed description of dualities in information processing, according to which there are two main dimensions, namely abstract vs. concrete and sequential vs. random, that generate four possible information-processing preferences (see Figure 1.4). Each profile has a preference for a definite kind of instruction and guidance, which could be taken into account while designing the program<sup>4</sup>.

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<sup>4</sup> Once different learning styles are defined, two points still have to be analyzed in order to get practical indications for design. The first is that any learner actually presents a mix of preferred learning styles: how do they mix? How do they influence each other? Secondly, given that the preferred style of each learner is identified, a strategic concern may raise: should the instruction follow as much as possible the learners' styles, or should the instruction provide them with a chance to learn and use different styles?

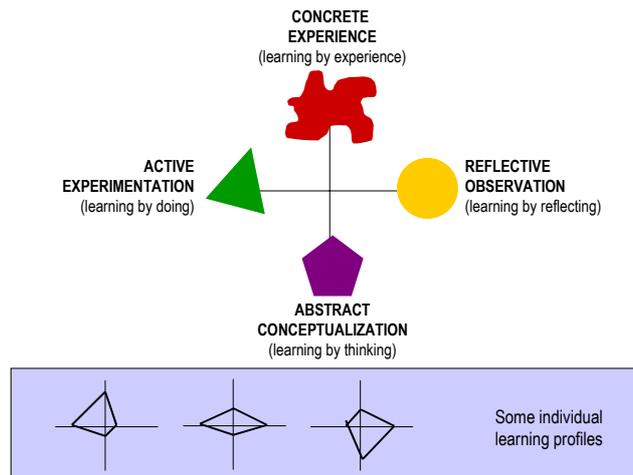


Figure 1.3 - A representation of Kolb's learning Styles (taken from Kolb 1999)

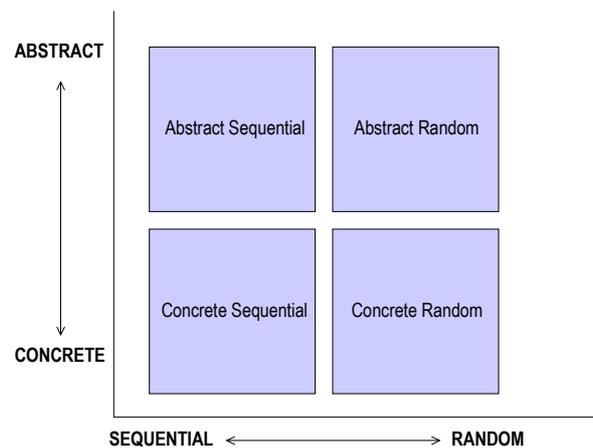


Figure 1.4 - Gregorc's information processing styles

### State Objectives

After the learners analysis, the ASSURE model introduces a novelty with respect to ADDIE: the explicit definition of learning objectives (ADDIE included it in the Analyze phase). The explicit statement of objectives is indeed an important, deciding and difficult phase in the instructional design process to which a large part of this work is devoted.

One great difficulty with learning objectives is that they must be somehow related to the evaluation as both learners and teachers should be evaluated on the basis of their achievement. One possible solution is the one proposed here: learning objectives should be specified as behavioral objectives. This means that a goal is the production, in the learners, of an observable and therefore testable behavior. This is perhaps one of the most controversial issues in Instructional Design as learning, as such, does not involve any physical or observable behavior: what can be observed may be a consequence of what has been learnt, but is never learning as such. Understanding a physical law is not observable, what is observable is its correct application to a given problem. The distinction becomes more evident if we think of “possessing a correct concept of *particle*” in Physics: the only way to observe it is letting the learner produce a verbal definition of it. But does this mean s/he has understood the concept, and is able to interpret situations according to it?

If learning objectives, in order to be testable should be observable and therefore should be expressed only as behavioral objectives is an open issue both for its feasibility and practicality, and will be discussed thoroughly in the last part of this Chapter.

ASSURE divides goals in four domains, namely cognitive, affective, motor skill and interpersonal. ABCD is then introduced as a sub-model for correctly expressing behavioral objectives in all domains. As usual, it is an acronym, and stands for:

- Audience: who the target learners for the objective are (e.g. all students; all students in the technology trail).
- Behavior: the performance representing the objective, i.e. the expected learning outcome (e.g. naming the capital cities of all the USA; solve an equation).
- Condition: under what condition the students should be able to achieve the performance (e.g. in one hour during a written exam; working in group).
- Degree: what mastery degree is expected from the students, or what degree of performance is considered acceptable (never fail an equation; get 10 right answers out of 12).

Expressing objectives according to the ABCD guidelines improves the degree of detail, imposes a greater explicitness, and provides a strong basis for developing test items.

### Select Methods, Media and Materials

The third phase focuses on the instructional activity itself. This is done by selecting the methods to be used (the instructional activities), the delivery media and the learning materials, and corresponds to ADDIE's Design and (partially) Development phases.

*Methods* include the kind of activities that can be performed (group discussions, a field trip, a lab experiment, a group work, etc.); *media* indicates the delivery media (face-to-face, video, Internet-based, etc.); finally, *materials* refers to the objects used as learning support (books, photocopies, pictures, a Web site, etc.). Materials can be selected, adapted and integrated with one another or, if necessary, developed from scratch.

Interestingly, the keyword here is *selecting*. Given the typical situation for a classroom-oriented model, the teacher-designer is not in charge of producing materials. Her/his task is rather to select the best solution among available and affordable opportunities.

The selection process is split into sub-steps: choosing a media format, requesting and obtaining specific materials, selecting available materials (maybe not all requested materials are available), modifying available materials and designing new materials. The criteria indicated for the selection stress the adequacy to the learners, to the curriculum and to the specific situation. Material-specific criteria address the issues of information quality, availability, currency, costs, etc. Obviously, a unit of instruction may switch among different methods and combine more delivery media with several materials.

### Utilize Media and Materials

The selection phase has defined the overall structure of the learning activity and predisposed all the necessary elements. It is now time to use all that, and the teacher-designer passes through another sub-acronym: PPPPP (or the 5P's), which stands for:

- Preview the materials: they should not just be available, but should be perfectly known to the instructor, who should integrate them in her/his presentation, complement them with other materials, etc.
- Practice the presentation: once materials are ready, the instructor should try them out, technically and as content, in order to avoid any inconveniency. It is therefore suggested to practice the presentation – the keyword here is *showmanship*<sup>5</sup>.
- Prepare the environment: the environment in which the learning experience will take place, and its facilities, should be suitably arranged for that: ordered, comfortable, well lit, etc.

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<sup>5</sup> Heinich, Molenda and Russell's text provides indeed an extremely interesting special on public speech.

- Prepare the audience: the learners should be prepared to the activity by providing them an overview of what will happen, expressing the goals, raising interest, etc. This will help focusing their interest and raising correct expectations.
- Present the materials: finally, the learning experience can be delivered, with all necessary guidance and unforeseen inconveniences.

### Require Learner Participation

This phase is not temporally sequential with the previous one, rather represents a particular care during the learning experience. The idea is that learners should be actively and individually involved, and not just passively “attending” to the teacher or the media. This can be achieved by offering opportunities to manipulate the information, have peer-to-peer interaction, produce media elements, etc. Learners’ active participation is not limited to the class: follow-up activities are also a matter of concern, in order to give the learners the time to process and digest the information.

### Evaluate and Revise

Like in ADDIE, the last phase includes an evaluation of the learning experience and the revision of the whole process. ASSURE evaluation concerns the learner achievement (formative evaluation), the media and methods (summative evaluation) and the instructional process, i.e. the whole process of analysis, design and enactment.

Insightfully, ASSURE indicates that the process of evaluation should not be limited to the final part of the instruction, or as an additional part at the end, but should be actually designed as a concurrent and continuing process before, during and after the learning experience. The elements for evaluation should be collected all along the process, and should include all the elements: learners, methods, media, materials and the instructor. Evaluation should clearly be primarily referred to the achievement of the learning objectives stated in the second phase.

Synthetically, ASSURE could be represented as in Figure 1.5, which represents the evaluation and revision phase as a continuing task that follows the whole process and gives it a cyclic structure.

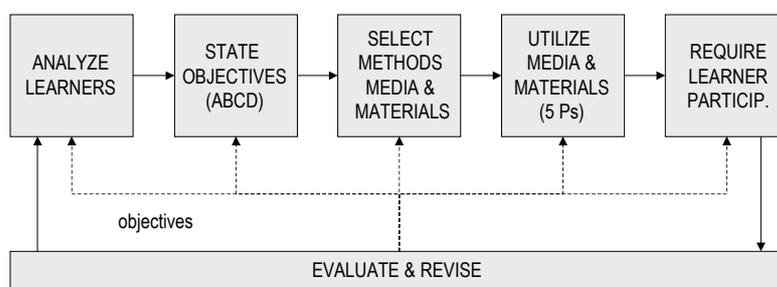


Figure 1.5 - The ASSURE model

ASSURE is a media-oriented evolution of ADDIE. While the main structure remains almost the same, a special focus is on the selection and integration of support materials and communication tools into the learning experience. Despite the intrinsic simplicity of the model, the work by Heinich, Molenda and Russell represent a major improvement in Instructional Design. ASSURE should in fact be understood in context. *Instructional Media and the New Technologies of Instruction* presents ASSURE as a general model in Chapter II (Systematic Planning for the Use of Media), and then focuses on the production of several types of instructional media: visuals (projected and non-projected), audio media, motion media, computer programs and multimedia systems (in 1993!), and simulations. The book’s main contribution is actually proposing the development of instructional materials as a key for the improvement of the quality of learning. The authors’ idea is that well designed materials may free the instructor to do what humans do best: personal interaction. Implicitly, the book also raises the issue of

what competencies are required for an instructor in an age when technologies are more and more taking a major role in education and communication.

The first two models were strictly related and like them there are many others. The next three models have instead a different focus and perspective, and are consequently not directly comparable with the previous two. The designer could see them as complementary tools.

## ARCS

Instead of addressing the issue of a successful learning experience *tout-court*, Keller conducted a year-lasting research focused on a specific issue and developed the ARCS model as a model for motivational design (Keller 1983; Keller 1984; Keller & Suzuki 1988; the model actually evolved from some previous writings, published since 1979). Motivational design is defined by its author as the process of producing *materials* that can enhance motivation in learners. The topic is utterly interesting as motivation, as exposed in Tenet 1, is a fundamental condition for successful learning, and ARCS is one of the few models specifically developed for addressing this issue. Another contribution is by Eccles and Wigfield (2002a; 2002b).

Keller bases his work on the expectancy-value theory, which defines *effort* as the major measurable motivational outcome. For an effort to occur in order to accomplish a task, two main conditions should hold:

1. The actor must value the task.
2. The actor must believe s/he can succeed at the task.

The ARCS model translates this idea into four categories, which are then matched to a number of strategies aimed at engaging learners actively into the learning task. Finally, a minimal motivational design model is proposed, for being integrated with other instructional design models. ARCS is an acronym of its four basic categories, presented in the following paragraphs: Attention, Relevance, Confidence and Satisfaction.

### Attention

The first goal of a teacher is getting the learners' attention, and her/his great challenge is sustaining it all along the instruction. Attention, eventually manifested as curiosity, is a necessary precondition for learning, as it is the expression of intentionality. When attention is lacking, even the most interesting things just pass by. The ability of the instructor is thus keeping a virtuous balance between boredom (nothing interesting stimulates learners) and anxiety or over-stimulation (when no stimulus can be properly focused). Gaining and keeping attention can play on different strategies:

1. Presenting an incongruity or conflict, such as a strange picture, a video, an unexpected action, an unknown object, etc.
2. Being concrete, such as using visuals, drawing examples, or telling anecdotes.
3. Using variation, i.e. changing relatively often the presentation method or the activity type, in order to avoid the establishment of "boring" routines.
4. Using humor, not only for the *captatio benevolentiae*, but as well for keeping the attention while providing simple factual information.
5. Fostering *inquiry arousal*, i.e. addressing the learners' intelligence with some puzzling issues.
6. Enhancing participation, making the learner active through role-playing or games.

### Relevance

Once that the door of attention is open, the instructor's task is to let the learners perceive the relevance of the learning activity. This can be achieved by focusing either on content (what is being learnt is relevant for the learner's professional life) or on the activity (cooperative work is relevant as it helps learners acquiring confidence with others). Showing relevance means expressing or suggesting the answer to the question "What is in it for me?" The ARCS model proposes six main strategies for relevance:

1. Experience (or familiarity): the learning activity recalls, or values the learner's previous experience. Presenting content in a way that is understandable to the learners makes it easy to relate it to their own experiences, which are the only ground on which relevance can be perceived.

2. Present worth: motivation is much higher if the topic learnt has an immediate value, i.e. if the learners can perceive that it will affect them now, as they are. This does not exclude that the main value is postponed in the future (as it often is the case with school training), but stresses the fact that a possible golden future is seldom a drive if compared to a real boring present.
3. Future usefulness: the impact that the new learning will have on the future activities is a key for relevance, as it can provide the openness for teaching not just on-demand (present worth), but also having in mind future evolutions and possibilities.
4. Motive matching: an important element for relevance is conceiving activities that provide responses to the perceived needs of the learners – full guidance for learners that are in want of authoritative characters, or collaboration for those in want of relationships, etc.
5. Modeling: showing “the effect of learning” embodied in a person who has “gone through” the same experience (an alumni, or the instructor) makes the final outcome clear and hopefully desirable.
6. Choice: leaving learners the choice of selecting a meaningful organization or method may make the learning activity more relevant to them.

Relevance is a key element in the learning process as it is in communication in general. The conditions of success of communication include the fact that the message “has to do with” the addressee, as a precondition for a real involvement.

### Confidence

We may now suppose to have attentive and involved learners that really perceive the relevance of the learning experience. Still, involvement may be hindered by uncertainty, by the fear of errors, of failing an exercise or missing an answer in front of the class. It is the second element of the expectancy-value theory: “the actor must believe s/he can succeed at the task”. Taking care of confidence means trying to make these obstacles the least important in a learning environment, to make learners feel at ease. Confidence may act as a self-fulfilling prophecy: learners that believe they can achieve determined goals are more likely to actually achieve them even if they are particularly challenging. ARCS proposes five guidelines:

1. Stating clear learning requirements will make learners more confident. Offering self-assessment sessions, and revealing criteria for the evaluation could enhance this.
2. Handling difficulty sensibly means proposing increasing levels of difficulties: learners will be more motivated if small successes are experienced during the learning process, instead of postponing a final (and dreadful) big evaluation in the end. Moreover, a continuous step-by-step evaluation, although costly for the instructor, may provide useful feedback. The basic idea is to try to put the learners in a situation where they always possess the learning requirements for the next step.
3. Realistic expectations: learners should perceive that the instructor’s expectations are realistic in terms of amount of skill and labor, in order to avoid learners not even start a work they think out of reach.
4. Helping learners do correct attributions in cases of success or failure, i.e. not letting them attribute a good result to “luck” or a failure in a test to an “ill-phrased problem statement” (obviously, when this is not the case!).
5. Opportunities for increased learner independence (self-confidence) are another important element: after having provided the necessary guidance, learners should learn to walk on their own feet. It is important that the educational environment offers opportunities where learners can independently apply and practice new skills and knowledge, so that they may build self-confidence.

### Satisfaction

Finally, learners should get some satisfaction at the end of the learning experience, once they achieved the desired goals. The reward should be tailored to the specific grade: a game or entertainment, a mark, a certificate, a special prize, etc. In accordance to the behaviorist principles that underlay the model, satisfaction can be provided through *intrinsic reinforcements*, i.e. by expressing the enjoyment of

the learning experience in itself; or *extrinsic reinforcements*, i.e. by providing awards, certificates or encouragements (the mark!).

ARCS proposes five reinforcements:

1. Natural consequences: instructors should not hinder the normal effects of learning, i.e. the positive feedback learners may get from the real environment, or the fact that those who have finished first may help others.
2. Unexpected rewards: difficult or boring tasks may be made lighter if the instructor provides extra-rewards.
3. The instructor should recognize positive outcomes while negative influences should be avoided (surveillance, threats, etc.).
4. The scheduling of feedback should be structured: probably more intense in the beginning, and growing rarer with the increase of competence on the learner's side
5. Finally, equity should be the constant for feedback, maintaining consistent standards and consequences for success, and informing learners about them before the evaluation takes place.

### The Motivational Design Model

The application of the aforementioned strategies in design is guided by a four-step motivational design model that should be integrated, or run in parallel, to another instructional design model. The idea is that particular elements of the instruction should be devoted to fostering motivation, and should be seamlessly integrated in the activities.

The steps are much like ADDIE's:

1. Define: classify the problem, analyze learners' motivation, and define motivational objectives.
2. Design: generate potential motivational strategies and select the appropriate ones.
3. Develop: create motivational elements and integrate them in the instruction.
4. Evaluate: conduct prototyping and assess motivational outcomes.

Acutely Keller observes that, motivational issues can be found in any situation. Moreover, if motivation is not an issue (the audience is composed by e.g. professionals who directly asked for such a training), the presence of motivational elements may even destroy motivation. Generally speaking, in education like in theater, no action is equal 0.

The ARCS model was applied to teacher training and to the design of CAI instruction units. Its particular merit and relevance is providing a set of features for describing operatively one of the most important, delicate and complex aspects of education, namely motivation.

### *Gagne's Nine Events of Instruction*

A personality who much influenced the development of Instructional Design is Robert Gagné. His work (see e.g. Gagné 1985; Gagné, Briggs & Wager 1992) addresses several issues, proposing both theoretical insights and practical solutions. His main contributions are

1. A "bare-bone" analysis of the learning process as stimuli, information processing, memorization and effectors, as a completely internal process.
2. The description of different kinds of learning goals (or types of knowledge), for which learning processes are specialized.
3. The definition of nine events that activate an effective learning process in any educational environment. Descriptively, they represent external events that can aid the internal learning process; prescriptively, they represent a blueprint for the design of educational activities, a set of conditions of learning.

While the taxonomy of learning objectives will be presented and discussed later, this section focuses on Gagné's Nine Events. The following picture (Figure 1.6 - taken from Gagné 1985, p. 304) provides an overall description of the learning process and the corresponding events. To those familiar with learning theories, it will be clear enough; for others the proposed references may provide all the necessary information.

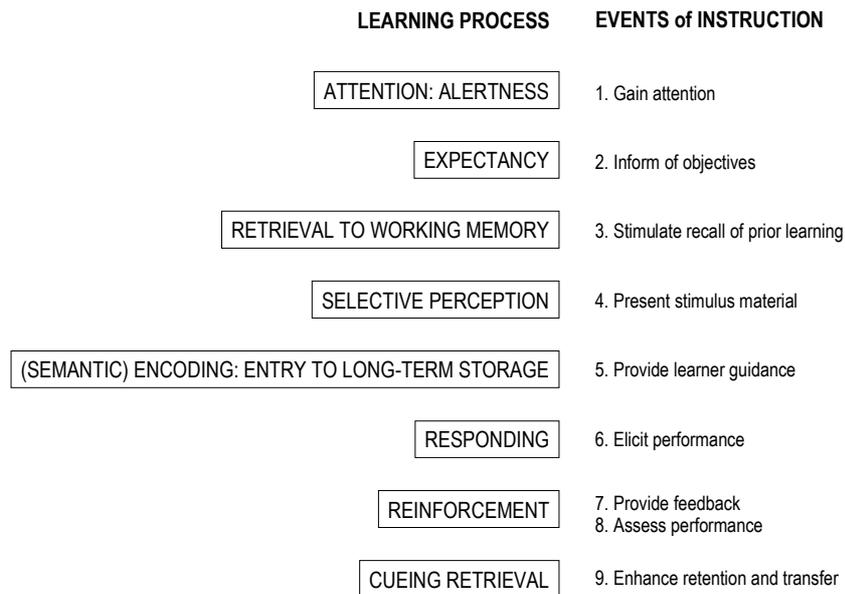


Figure 1.6 - Gagné's learning process model and events of instruction

The Nine Events are here relevant as a model for design, and under this perspective each event is discussed in the following paragraphs.

1. *Gain attention*: as in the ARCS model, the first thing that should happen in order to make learning possible is focusing the learners' attention on the subject matter and on the learning activity as such. It is the primary condition for *reception*. The indications proposed by Keller reported above may provide enough information about this point.
2. *Inform learner of objectives*: learners should be made aware of the goal(s) addressed during the instruction, in order to create correct *expectations*. Moreover, declaring the learning objective may promote meta-cognition (learning to learn), self-assessment of one's own achievements, and may make the learning activity relevant.
3. *Stimulate recall of prior learning*: building on previous knowledge is a necessity, and it is better to make it explicitly and guide the *retrieval*, in order to verify that no learning gaps block the process. Moreover, the emphasis on previous achievements is important to develop a commitment and to create trust.
4. *Present stimulus material*: all learning starts from an external stimulus – a problem, a question, something unknown. This means to *draw attention selectively* on a specific topic and let questions arise. From Gagné's perspective, and this is an important contribution of his, the materials act as a stimulus on learning, but do not make learning happen: they can be a sparkle, but the burning wood, and the oxygen, should be put by the learner.
5. *Provide learner guidance*: once the process of learning is started, the creation of meaning or *semantic encoding* can be guided and supported by the teacher, for example offering unifying schemas or suggesting thinking in images. This clearly relates to the topic of learning styles. It is the idea of scaffolding, of providing tools and support that may hinder failures and promote correct intuitions.
6. *Elicit performance*: in order to confirm that they have learnt, learners should be asked to produce something or accomplish a task, to definitely switch to an active role.
7. *Provide feedback*: the learners' performance should be followed by the instructor's feedback, for detecting gaps and for providing *reinforcement*.
8. *Assess performance*: the assessment is an important event as it provides a final and official, maybe standard, evaluation of the learning outcomes for the single student.
9. *Enhance retention and transfer*: while most models would have stopped at number eight, Gagné also introduced an event concerning *generalization*, the transposition of the new knowledge to the real

activity in a professional environment or a further learning activity. An educational activity should include devices or sub-activities that reinforce the retention of learning and its effective application, in order to meet the real educational goals.

Merril (2003) recently proposed a similar approach, from a different epistemological perspective, with his 5-star instruction.

Differently from ADDIE and ASSURE, the nine events are focusing with great detail on the very activity of learning, and not on the design process, and they describe the learning process from within. It is the same feature of ARCS, and it may be worthwhile to draw a short comparison between the two of them, as in the Figure 1.7:

	Attention	Relevance	Confidence	Satisfaction
Gain attention	■			
Inform learner of objectives		■		
Stimulate recall of prior learning		■		
Present stimulus materials	■			
Provide learner guidance			■	
Elicit performance			■	■
Provide feedback			■	■
Assess performance				■
Enhance retention and transfer				

Figure 1.7 - A comparison between Gagné's nine events and ARCS

The gray areas indicate where each event can be related to the four ARCS categories: for instance, providing feedback on a performance is a way of fostering confidence, while expressing the learning goals is a way of eliciting the relevance of the instruction. Of course elements and categories cannot be said congruent, and it would not be acceptable to say that ARCS's attention is equal to gaining attention and presenting stimulus materials. What makes this parallel possible is the recognition, in both models, that motivation and personal engagement play a key role in learning. While ARCS focuses on the internal factors that enhance motivation, Gagné describes the steps the instructor should take care of for fostering it, and calls them *events*, i.e. occurrences that produce a commitment in the learner.

### *Landamatics*

Although it can be as well used on a larger scale for designing a whole course, this model was placed in this section as it represents a class of models specifically designed for a particular kind of learning objectives and aimed at providing detailed guidelines for developing an educational activity.

Lev Landa's theory (originally conceived while he was in the USSR, back in 1955; then further developed in Landa 1974 and Landa 1976; then e.g. Landa 1983 and Landa 1993) is concerned with teaching and learning mental operations, cognitive strategies or procedures. Its main idea is analyzing an expert's way of solving a problem or performing a procedure, breaking it down to units and configuring an instructional unit. This theory is interesting as it relays on a particular formalism and takes a strong epistemological position on the nature of cognitive strategies and procedures.

*It is common knowledge that pupils very often possess knowledge that is necessary in a certain subject, but they cannot solve problems. Psychologists and teachers often explain this by saying that their pupils do not know how to think properly, they are unable to apply their knowledge.*

(Landa 1975)

Landa's starting point is that learning is often ineffective as learners are only presented knowledge (facts, concepts, etc.) but do not know what operations they could or should perform with it.

In order to solve a problem, and to teach to solve it, one may start observing an expert. The point is that experts perceive problem-solving abilities as unconscious, unexplained and somehow "natural". The instructor's goal is bringing novice students to this expert-level competence, and s/he can do it by analyzing the expert's behavior, breaking it down (e.g. flowcharting) into simple elementary steps, and teaching them one after the other to the learners, practicing them one by one and putting it all together in the end.

Let's take as the preparation of handmade *tortelli* with meat. Every expert – typically a middle-Italy grandmother – would not probably be able to express all the elements in the process, but would say put in the pot "enough water" or make the *pasta* "as thin as necessary" and let it rest "for some time". The observation of the process would reveal several phases (selecting the ingredients, making the pasta, cooking meat, preparing the stuffing, etc.). These phases can be taught separately, each with its own specific elements and difficulties, then practiced over and over until they are internalized and become automatic for the learners<sup>6</sup>. After that the method can be reprised and critically revised for deepening its generality and broadening its scope.

In order to teach algorithms – or generally speaking procedures – in a structured manner, Landa proposed the so-called *snowball method* (in itself an algorithm!):

1. Explain operation 1.
2. Let student practice operation 1.
3. Explain operation 2.
4. Let students practice operation 1 and 2.
5. Explain operation 3.
6. Let students practice operation 1, 2 and 3.
7. Explain operation 4.
8. Etc...

The fact is that not all problems are algorithmic in nature. According to Landa there are two kinds of problems that can be solved by procedures or cognitive strategies: algorithmic problems (that can be solved by applying always the same procedure) and heuristic problems (where the procedure must be at least partially redesigned according to the specific situation). While for the former ones the steps and the sub-procedures can be exactly defined (e.g. install a software), it is not the same for heuristic problems, where parts of the process may be guided by principles or general rules that must be adapted to the specific situation (e.g. designing instruction). Moreover, semi-algorithmic and semi-heuristic problems can be defined. All the same, the procedure for analyzing the process and creating the instruction for heuristic problems is structurally the same<sup>7</sup>.

Landamatics is therefore a theory that offers method for (taken from Landa 1983):

- *Uncovering* conscious and unconscious processes underlying abilities of expert learners and performers to perform on mastery level.
- *Describing* explicitly the correctness and completeness of the descriptive models by designing prescriptions on the basis of descriptions to be tested as experiments.
- *Improving* the models.

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<sup>6</sup> If we would reprise here Lonergan's terminology, we would say that experts often possess a detailed *image* of the process, but no *concept* of it. The instructor's work could be described as conceptualizing the process, teaching it "from above" or conceptually and then practicing it until a complete image is reconstructed, and can serve as basis for a correct *understanding* of real instance problems.

<sup>7</sup> Landa actually argues that many problems we call heuristic are in fact complex unconscious algorithms. Moreover "What is a creative problem for one person may be algorithmic for another" (Landa 1993).

- *Optimizing* the models with formal optimization criteria.
- *Designing* final algorithmic or non-algorithmic ideal procedures enabling non-experts to perform on mastery level.
- *Identifying learning procedures* leading to the development of performance algorithms or heuristics in learners (i.e. a teaching strategy).
- *Designing algo-heuristic teaching procedures* for the instruction, i.e. designing an algorithm for the instruction.
- *Designing* all learning materials for the algo-heuristic instruction.
- *Designing evaluation methods* for the efficiency of the instruction.

The basic elements, and the particular nature, of this approach are a strong hypothesis on the type of knowledge and expected learning outcome and a very detailed process for the definition of an instructional procedure. Landamatics is concerned not only with the layers of design and procedures, but also puts forth a definite hypothesis on the approach layer.

### **Product-Oriented Models**

The second group in Gustafson and Branch's taxonomy includes models focused on the development of instructional materials, tools for interaction or for presenting content as support to the instruction. With respect to classroom-oriented and system-oriented models, it is like zooming into the Develop Materials phase. These models consider situations in which a development team is at work with a high degree of technological complexity. They require fine design and technical skills. The requirement analysis is presupposed. The strength of these models is the production of highly distributable and reusable learning materials and tools.

Left the Learning Object trend apart, which gained space in the last years, this is indeed a gray area in Instructional Design. The development of instructional materials usually belongs to experts in the different domains of graphics design, text editing, and multimedia or software development. It is in fact an open issue if education is such a specific domain to justify the definition of specialized development methods.

The issue of learning materials has become particularly relevant with new media and distance learning. On the one side new media offer before unthinkable possibilities (multimedia, interactivity, just-in-time distribution via the network, etc.); on the other side, distance learning imposes a more massive use of materials, face-to-face presence being costly and sometimes impossible. This is why the models presented in the following paragraphs mainly address the development of educational software or hypermedia. The work of Heinich, Molenda and Russel (1993) from which ASSURE was taken, was an attempt to explore the same dynamic with non-electronic media. A review of the impact of information technologies on education can be found in (Lawyck 2002), while a specific method for the design of adaptive hypermedia applications for education is presented in (Armani & Botturi 2003). A wider review and comparison of product-oriented models can be found in (Moonen 2002), while (Oppermann 2002) proposes interesting insights about the sub-topic of user interface design for educational software.

#### *CADMOS-D*

One trend in educational material development is the specialization of generic models such as UML (UML 2001) or W2000 (VNET5 2002). UML (Unified Modeling Language) is a general purpose modeling language developed for object-oriented software design, and is the *de facto* standard in this field. W2000 is an evolution of HDM (Hypermedia Design Model, which was actually borne before UML was released, Garzotto 1993), a conceptual model for the design of content-oriented hypermedia applications. One trial for specializing such languages for eLearning software development is CADMOS-D (Retalis, Papasalouros & Skordalakis 2002; Psaromiligkos & Retalis 2002).

The object of CADMOS-D are Web-based educational applications – notice that the scope is shifted from a whole educational environment, or from a set of educational activities, to the development of

an application, i.e. a tool to be exploited within the activities. According to this model, an educational application can be conceived as

*(...) a mosaic of learning resources, such as hierarchically arranged sets of pages of an electronic book, web testing resources, on-the-fly pages, site maps, search engines, etc.*

(Retalis, Papasalouros & Skordalakis 2002)

The CADMOS-D approach integrates a standard UML-like notation for software development with the HDM design process structure, thus decomposing the design process in three main phases, represented in Figure 1.8.

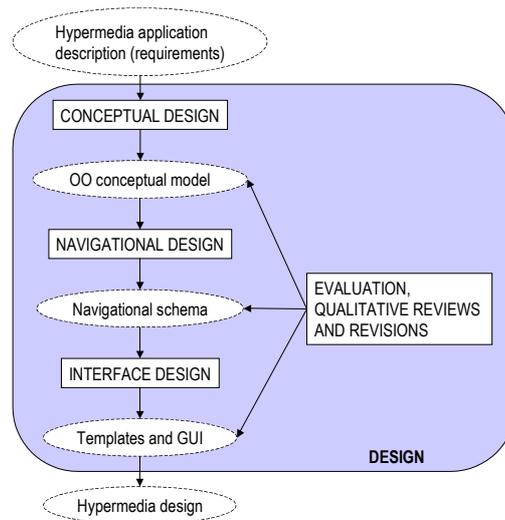


Figure 1.8 – The CADMOS-D design process

Three steps (the white rectangles) form the design process (the rounded gray square), each producing a specific output (the ovals):

1. *Conceptual design* produces an object-oriented model of the application (*hyperbase*, according to the HDM terminology). CADMOS-D takes for this phase two tools from the UML toolbox, namely *use-case diagrams* and *class diagrams*, and proposes an abstract object-oriented meta-model.
2. *Navigational design* consists in defining the possible paths that users will be enabled to follow through the resources. At this level, navigation patterns can be a powerful tool. The output of navigational design is a navigational schema.
3. Finally, *interface design* copes with defining the user interface and the actual Web pages.

The greatest effort done by the developers of CADMOS-D has been aimed at developing an UML-like meta-model for conceptual design. The meta-model allows educational software developers to define their products with great detail, and considers two main parts:

1. The Learning Resource Model specifies the kind of Web page (access page, content page or Web testing resources) and its relationships with other resources through links.
2. The Web Page Atomic Elements Model specifies the items composing each Web page (content slots, media elements, active elements, forms elements).

The meta-model schemas are legible only for technical people and are not necessary for the goals of this Chapter; they are available in (Retalis, Papasalouros & Skordalakis 2002).

The CADMOS-D model is almost a unique trial in its context. The outcome is a very technical model, usable only by software developers, which produces low-level specifications. Any example of

modeling is clearly unreadable for a teacher or a technically unskilled educational designer, as it presupposes familiarity with UML notation standards. Moreover, documenting the design process with this model is not economic, as it requires a huge investment in terms of time in order to get the necessary level of detail. This does not mean it is not useful – rather that it is useful *outside* the instructional design process, namely in the case in which an instructional designer let some software developers produce an application for which s/he only provides the requirements.

Moreover, two short remarks should be taken into account concerning any educational application development model. The former concerns the specificity of such an application design model – what is specific for education in CADMOS-D? To a detailed analysis, this model only provides general primitives that could fit almost any situation, except for two of them: the learning goals (an attribute of the resource itself) and the Web test. Are they enough to grasp the peculiar nature of an educational application? The latter remark concerns the narrow scope of CADMOS-D, which only considers Web-based hypermedia application: why not including offline hypermedia applications? Moreover, the integration of Web-based applications with other media (both electronic and not) seems to be one important element in this domain, so that a specific word was created for that, *blended learning*.

Both remarks have been considered in another strand in eLearning: the development of learning-object metadata.

### *The Learning Objects Trend*

Research on Learning Objects is a new trend in educational technology that is likely to influence the instructional design practice. This trend cannot be formally considered part of Instructional Design; nevertheless, given its success, the entity of investments and its current evolution, is something which instructional designers will have to deal with.

The idea (originally related to the semantic Web – see Berners-Lee 1998) is to develop a metadata<sup>8</sup> standard for tagging educational resources in order to enhance exchange, reusability and automatic content management. A learning object is therefore a single resource along with some metadata describing it.

Physically, a learning object can be almost anything (as anything can be used for learning). Some definition put the constraint of being digital (a PowerPoint presentation, an animation, a video, a set of Web pages, a collection of all these resources, etc.), while others include also non-digital resources (a book, a microscope, etc.). A learning object should be consequently context-independent and self-contained: it should be usable in a different course than the one for which it was originally developed, and be suitable for the integration with other learning objects, eventually produced by different people in different institutions.

The Learning Object domain is growing more and more. The short review proposed here is no way exhaustive, but provides some general guidelines and the necessary references for further information. A more complete exploration of the field can be found in (Innes & McGreal 2002).

### LTSC Learning Object model (LOM)

The Learning Technology Standardization Committee of the IEEE (LTSC) proposed a first definition of Learning Object as “any entity, digital or non-digital, usable for learning, practice or instructional activities”.

LTSC goals in defining learning objects are the following:

1. Specify a conceptual metadata schema for a learning object.

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<sup>8</sup> Metadata are generally defined as “data about data”, i.e. some data describing another data source. More precisely, tailored to our context, they can be defined as “(machine understandable) information about a web resource or something else, (usable by) intelligent software agents (...) to make the best use of the resources available on the Web. They also can be described by other metadata” (taken from a W3C talk available online at [www.w3.org](http://www.w3.org), February 2003). An example of metadata is the following: “Metadata are data about data. They help you find and use information. A library catalogue entry gives you a book's title, author, subject, number of pages, publisher, publication date, and location in the library. It could be considered the book's metadata. It not only helps you find the book; it helps you decide whether the book will be useful. More extensive metadata about the book might tell you what typeface was used, what kind of research the author did before writing the book, and how reliable you can consider it” (from <http://www.library.wisc.edu/data/GIS/whatmeta.htm>, August 2003).

2. Create a reference schema for other standards implementing that schema (this would grant at least some degree of interoperability among different standards).
3. Facilitate the search, use, evaluation and acquisition of learning objects by students and instructors.
4. Facilitate sharing and exchange by fostering the development of metadata-based catalogues of learning objects, taking into account linguistic, cultural and context differences.
5. Provide criteria for assessing the compliance of a learning object and its metadata with the standard.

The LTSC output was the Learning Object Model (LOM – see LTSC 2001). The complete model will not be presented in the following pages, as it is enough to recall that LOM proposes different metadata categories, which are the following:

- *General*: general information about the learning object (title, subject, author, etc.).
- *Chronology*: the development history and the current status of the learning object (finished, revised, etc.).
- *Meta-metadata*: information about the metadata standard used for specifying the metadata.
- *Technical*: information about the technical features of the learning objects and the technical requirements for using it (for example a specific media player).
- *Educational*: the educational features of the learning object, such as its suitability to a particular learning strategy.
- *Copyright*: the terms of use of the learning object.
- *Relation*: if the learning object has relationships with other learning objects, such as it is thought as part of a specific sequence of learning objects.
- *Annotation*: a space for collecting comments and remarks about the use of a learning object, eventual corrections, updates, etc., along with information about who wrote them.
- *Classification*: if a classification schema of learning object exists (as part of the metadata standard), here the class of the learning object can be reported, along with a reference to the schema.

It is important to point out that this is a conceptual schema: LTSC does not propose any implementation strategy for metadata or learning objects. This general schema represents the core of other standard proposals, which are presented in the following paragraphs.

### IMS

The Instructional Management System Project (IMS) is part of the EDUCOM consortium, and is composed by several American Higher Education institutions along with players in the eLearning market. Since 1997, IMS worked at the development of open commercial standards for online learning, and tackled the topic of learning objects metadata.

Differently from LTSC, the IMS definition of Learning Object only considers digital entities. IMS produced a set of documents guiding the implementation of learning objects, thus moving one step further from LTSC-LOM. The implementation strategy proposed by IMS proposes XML as metadata development language.

The main IMS achievements in terms of specifications for learning objects are the following:

- *IMS/LOM Meta-Data*, which is the core specification of learning object metadata (IMS 2003d).
- *IMS Content Packaging*, concerning the development of “units of learning” (IMS 2003b).
- *IMS Simple Sequencing*, concerning the sequencing of resources within learning object and sequencing more learning objects and services within a learning environment (IMS 2003c).
- *IMS Question and Test Interoperability*, concerning assessment resources (IMS 2003e).

Moreover, other specifications were delivered, which are not strictly related to the production of learning materials:

- *IMS Learner Information Package*, which defines user profiling within an educational environment (IMS 2003f).
- *IMS Learning Design*, which describes a whole learning environments (IMS 2003a this will be addressed later on in this Chapter).

- *IMS Reusable Definition of Competency or Educational Objective*, which deals with the expression of learning goals (IMS 2003g this will be addressed later on too).
- *IMS Enterprise*, for describing the organization that hosts the educational environment (IMS 2003h).

Along with some modification of the LTSC-LOM standard and the proposal of an XML binding, IMS also provides guidelines and tools for creating extensions to the schema using DTDs. This is an important and controversial topic, as no standard will be ever able to describe all possible kinds of educational activity or resource (it is the same limit detected with CADMOS-D some pages above, although on a different level), and the usefulness of metadata is their actual matching with the learning object they describe. For this reason, IMS always specifies what extensions of the model are allowed. On the other side, any extension endangers the very nature of the standard by creating a chance of semantic incompatibility.

### AICC

The Aviation Industry CBT Committee (AICC) is a non-profit organization born in 1998 with the purpose of developing content and learning experiences based on new technologies in the field of aviation and marine.

Like IMS and LTSC, AICC also provides guidelines for learning object development, but with a somewhat different perspective from the other two organizations. The main achievement of AICC, exploited also within the SCORM standard (see below), is the CMI - Computer Managed Instruction, the specification of a software application that selects and sequences content presentations and learning activities for the student. It is particularly important, as it is a first attempt to provide a platform for the application of learning objects. CMI in fact defines two main elements that are not present in other standards:

1. A user model, i.e. metadata about the learner that specify her/his identity, goals and status; examples of information in the learner profile are personal information (name, age, school grade, etc.), the last learning object visited, the last result in an evaluation, etc.
2. A set of API (Application Program Interface) that specify the possible interactions between a learning object and the eLearning platform, which represents the context in which a single learner uses the learning object. APIs are e.g. *launch* a learning object, *close* it, *save* the result of an evaluation in the learner's profile, etc.

### SCORM

The most recent initiative concerning learning objects was proposed by the Advanced Distributed Learning organization (ADL), created by the US Department of Defense and the White House Office of Science and Technology Policy, with the collaboration of several research and commercial organizations.

One of the goals for ADL was to coordinate the different commercial and open initiatives in this domain. It accomplished that task gathering the outcomes of LTSC, IMS and AICC and defining the Shareable Content Object Reuse Model (SCORM – see ADL 2003).

In order to achieve the goals of SCORM, ADL defined four main features required for eLearning content:

- *Accessibility* is the possibility to retrieve and access learning resources from a single workstation and to distribute them to other workstations.
- *Interoperability* is the possibility to get components from a workstation and to use with other tools or on a different workstation.
- *Durability* is the capacity to resist technological innovation without high redesign, reconfiguration or recoding costs.
- *Reusability* is the possibility to integrate learning components into different applications and contexts.

SCORM proposes a content model based on learning objects meeting these criteria, which are frequently referenced in the specification documents. With more detail, SCORM defines a model for

content aggregation (reprising LTSC-LOM and IMS) along with a runtime environment for the online exploitation of learning objects (integrating AICC-CMI). Moreover, an XML binding is proposed as implementation strategy.

SCORM learning objects are designed on three main levels:

1. Learning object: a self-contained learning resource (e.g. a set of Web pages).
2. Asset: a single file within a Learning Object (e.g. a GIF file image).
3. Aggregation: a structured set of Learning Objects.

This specification accompanies the definition of a runtime environment, which reprises the AICC contribution (CMI). The runtime environment specification would become the core element of any learning object-compliant Learning Management System (LMS).

Along with the specification of learning object metadata, SCORM also provides tools for verifying the compliance of a learning object with its schema, and a core implementation of the runtime environment.

### Concluding Remarks

This short review is surely not enough in order to provide a realistic picture of what is going on in the field of learning objects standards. Nevertheless, the topic was introduced for two main reasons. First, it looks like one of the major development in the field of new media in education; second, if learning objects will become a common practice, Instructional Design will require integration.

Moreover, the very idea of learning object presents some relevant issue from the point of view of the educational designer. First of all, the production of a learning object is a difficult enterprise, as it is neither simple nor always possible, to write learning content which is completely context-independent and reusable within a new context “as is”. The SCORM features for learning content not only require the existence of a technical standard, but also impose a new way of designing content. Every teacher knows that the success of instruction is not only bound to the quality of content (which of course is one of the most important elements), but also to its internal connections and consistency, and to the presence of a continuous flow of activity producing *one* meaning. Moreover, it is a matter of cost. Coding metadata is a time-consuming task: writing metadata for a SCORM or IMS learning object means filling more than 80 descriptors. Is that worth within the perspective of course development? It probably does if reuse or exchange (selling?) is considered, but this implies a new perspective in design, and a new attitude in the organizations producing instruction or instructional materials<sup>9</sup>.

Now let's take for a moment the perspective of someone retrieving from an online “eLearning store” some learning objects. How would you evaluate them, in order to see if they actually fit to your needs? Metadata are surely not enough. They can facilitate storage and retrieval, but what about evaluation and selection?

These remarks could sound skeptical, but they point out that a learning content standard is not a mere technical issue, as it implies great changes in the design practice and in the organizations. One promising outlook for learning objects is the integration with adaptive hypermedia systems, which can provide the basis for (semi-) automatic support to learning content management (Allert, Richter & Nejdil 2002).

### **System-oriented Models**

System-oriented instructional design models can be considered a full-fledged version of classroom-oriented model with a much broader scope: they consider the development of a whole course or program, with a huge investment by a skilled interdisciplinary team. In such a situation, the stress is on a fine requirement analysis and on a recurrent process of tryout and revision, in order to develop high-quality products. From the technology standpoint, the complexity can be high, and materials are usually developed within the process.

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<sup>9</sup> An extremely positive example of this new attitude can be found in the MIT Open Courseware project (MIT 2003).

This is the type of situation addressed by this work and by E<sup>2</sup>ML; as it will already be clear to the attentive reader, the issues put forth in the introduction mostly concern this level.

The complexity of system-oriented models is the reason why their number is smaller. The following pages introduce four major models plus a system-level metadata standard.

### *The Dick, Carey & Carey Model*

The Dick, Carey & Carey model (1996), also referenced by many as the Dick & Carey model, presents instructional design as a systemic activity, a system being “a set of interrelated parts, all of which work together toward a defined goal” (p.3). In order to consider all the parts in the correct order, and with the correct relationships, this model proposes a design process articulated in 10 phases, as sketched in Figure 1.9:

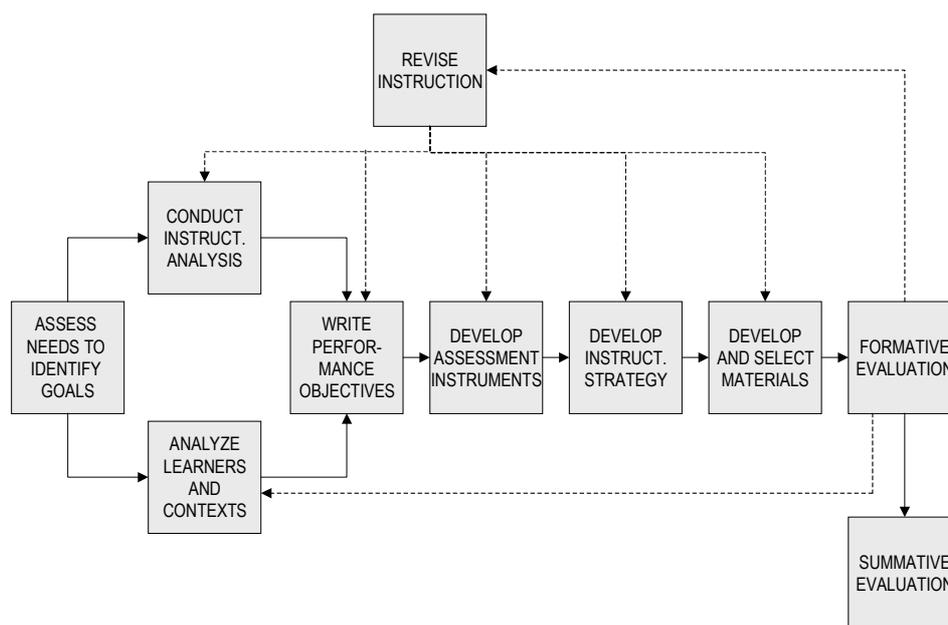


Figure 1.9 - The Dick & Carey Model

The whole process is tailored to course development. Each phase includes a specific task and provides input to other phases, as indicated by the arrows in the Figure. Dick, Carey & Carey also provide specific methods – some original, some by other authors – for each phase. For a simpler and more synthetic description of the model, the ten phases can be grouped in three main steps, which are presented in the following paragraphs.

### Requirement Analysis

The first step aims at understanding what should be taught, to whom and in what context. This step includes four phases:

1. *Assess needs to identify goals.* In this phase the designers should analyze the context of the instruction in order to define the specific problem that the instruction will solve. A major initial concern is determining *if* instruction is actually a possible solution for the issue(s) at stake. A company’s manager may require his to employees work more efficiently – is the issue that they cannot work efficiently, or is the technical infrastructure simply out of date? Instruction is a possible solution when a skill gap can be identified as one of the major problem components. Filling that gap will then be the goal of the instruction. Tools for the analysis are direct observation and interviews. The output of this phase is a set of statements concerning the issues at stake for which instruction is supposed to be an effective solution.

2. *Conduct instructional analysis.* Instructional analysis consists in analyzing the skill gap and determining the sub-skills necessary for filling it. Dick, Carey and Carey introduce here a representational method for instructional analysis, consisting in a progressive breakdown of skills into sub-skills until the identification of a basic entry-level, which groups all skills that learners are presupposed to have before entering the instruction. The process may be specialized for different kinds of goals (e.g. procedural goals, attitude goals or intellectual skills). Although the method requires a good deal of experience in order to be used effectively, the output is quite straightforward. An example is shown in Figure 1.10 (taken from Dick, Carey & Carey 1996, p. 72) for the competence “Given a scale marked off in tenths, and asked to identify the location of designated points on the scale to the nearest hundredths, read the scale in decimal form by estimating between two tenth divisions to the nearest hundredth, and report the reading to within +/- .01 units”. The main goal is marked as G in the Figure.

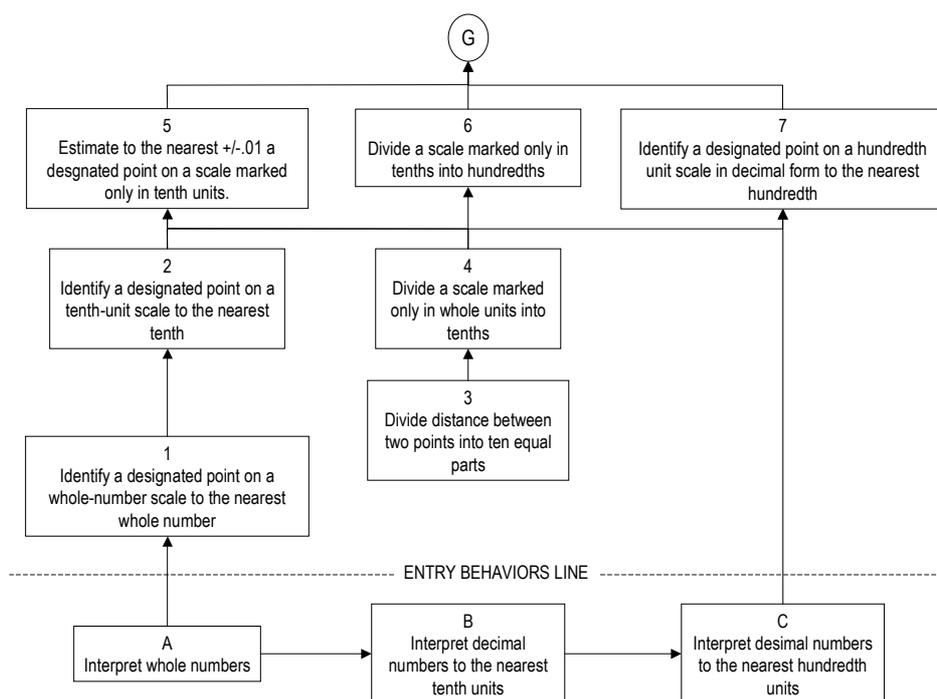


Figure 1.10 - An example of instructional task analysis

The importance assigned to instructional goal analysis is paramount, as the resources invested in goal analysis will result in the overall quality of instruction. The output of this phase is therefore a complete and detailed map of the instructional goals, its sub-skills and the entry behaviors. Yet the example clearly shows the high degree of detail that this method supports and at the same time requires; the complexity of the diagram for such a simple competence let the question arise about its viability for more complex ones.

3. *Analyze learners and contexts.* After having determined what to teach, the analysis focuses on who should learn it. The model proposes three elements:
  - a. The learners: their personal and social characteristics, their prior knowledge of the topic area and their entry behaviors, their attitude towards the instruction (toward the content, the potential delivery system, the organization, and their general learning preferences and motivation).
  - b. The learning context: the number and nature of sites, their compatibility with the instructional needs and with the learners' needs (opening hours, facilities, etc.), and the feasibility of simulating the performance context.

- c. The performance context: the context in which the new knowledge will be used in “real life”, the managerial/supervisory support, the physical aspects, the social aspects and the relevance of the new skills to the context.

The instruments for this analysis are interviews (with single learners and managers, small groups, or wide surveys), and the collection of evidence for the contexts. Dick, Carey and Carey offer detailed guidelines and checklists for the analysis. The output of this phase is a detailed description of the target(s) of the instruction and of the learning and performance contexts.

4. *Write performance objectives.* The formalization of goals into performance objectives concludes the requirement analysis step. Objectives specify the expected outcome for the instruction with greater detail than instructional goals do. Performance objectives are written according to the ABCD guidelines presented above: who should be able to perform a specific behavior, under what conditions, and to what mastery degree. While goals are high level (for example, “manage a group discussion”), behavioral objectives should only describe specific observable performances (“name at least five behaviors that promote group discussion and five that hinder it”). The assessment will develop tools for collecting evidence that learners can actually demonstrate those performances. The output of this phase is the formal expression of objectives as observable performances.

### Instruction Development

The development of the assessment is one of the differences between system-oriented design models and classroom-oriented ones. The scope of system-oriented compels them to consider it as a major concern, and the idea of the Dick, Carey & Carey model is that its definition is the pivotal point for connecting analysis and design. The first phase in this step is in fact the production of assessment instruments: knowing how learners will be evaluated is the key element for understanding how the instruction will make them successful. The development of an instructional strategy and of learning materials follows and depends on this phase. If the design process is structured this way, the translation of goals into assessment items central: it is often not easy to effectively assess the acquisition of a goal in an artificial learning environment (think of any attitudinal goal).

In more detail the phases considered for development are the following:

5. *Develop Assessment Instruments.* The development of test items means creating a benchmark or roadmap for the following phases. Dick, Carey and Carey present and discuss different assessment methods, relating them to the different kinds of learning goals. Test items should then be combined into a whole test, and guidelines are also provided for sequencing test items, setting the mastery degree, writing direction for learners and determining a scoring procedure. One important and not self-evident idea is that test items should be tested, in order to proof their effectiveness, their usability and the effective and unbiased assessment of the achievement of learning goals. The outcome of this phase is a set of test items, eventually already integrated into one test, related to learning goals.
6. *Develop Instructional Strategy.* An instructional strategy concerns “the various aspects of sequencing and organizing the content, specifying learning activities, and deciding how to deliver the content and activities” (Dick, Carey & Carey 1996, p. 184)
  - a. The first step is therefore determining the delivery system (large class, small groups, self-learning, WBT, etc.) according to the learning goals, the instructional setting and the actual possibilities.
  - b. Secondly, the content should be sequenced and clustered in units (which could be single classes, modules, activities, etc.).
  - c. Thirdly, the components of the strategy should be defined (i.e. the single activities; Dick, Carey and Carey propose here to follow Gagné’s Nine Events of Instruction), student groupings and the delivery media.
  - d. Once this structure is defined, the remaining decision is assigning learning objectives and the corresponding activities to lessons (or more generally, sessions) and to consolidate the media selections.

The whole process could be streamlined as in Figure 1.11.

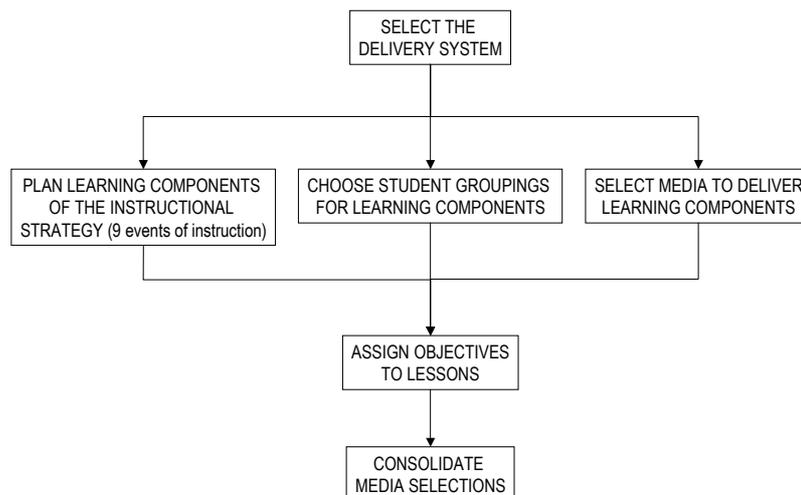


Figure 1.11 - A flowchart representation of the development of an instructional strategy

The strategy should be tailored to the specific kind of learners and of learning goals, and should also cover pre-instructional, assessment and follow-through activities. The instructional strategy should be proofed and evaluated by reviewing it with a sample of learners and with subject experts. The output of this phase is therefore the complete structure of the instruction: activities and the related content, the session structure, and the delivery system along with the specification of the necessary media components.

7. *Develop and Select Materials.* The last development activity is selecting or developing the materials necessary to run the activities. At this level only local decisions have to be yet taken, as the integration of a specific media or material into the overall instructional strategy was already defined in the previous phase. The main guideline here is that development is a costly process and that “cutting corners to save money will usually not impact students’ learning, but it will impact students’ attention and perceptions of relevance and authority” (Dick, Carey & Carey 2001, p. 234). The authors also warn “the first steps in adoption of a new technology are usually attempts to replicate the features of the old technology” (p. 234). With these two guidelines, the instructional designer should develop all the components of an instructional package, namely:
  - a. Instructional materials (content).
  - b. Assessment materials (implementing the already designed test items).
  - c. Course management information.

Moreover, specific guidelines are provided for the selection of already existing materials and for determining the role of the instructional designer into the development of new materials.

But once the materials are developed, there is still one step to go through: determining how the materials will be mediated, i.e. how the instructor will use the materials and how much guidance learners will need. The output of this phase is a ready-to-go instruction.

#### Evaluation and revision

The last step in the design process concerns the evaluation of the instruction and its revision. There are three phases:

8. *Design and Conduct Formative Evaluation.* Formative evaluation is the process of obtaining “data that can be used to revise (the) instruction to make it more efficient and effective. The emphasis (...) is on the collection and analysis of data and the revision of instruction” (Dick, Carey & Carey 2001, p. 285). Formative evaluation involves subject experts, learners and experts in the kind of learning outcome. For this purpose, the designer can use interviews (one to one or with small groups), direct observation in the performance context(s), and learner feedback. The objects to be evaluated are the instruction as a whole, the materials and the instructor or tutor activity. The data

collected as output of this phase provide relevant information for improving the instruction to fit better to the real needs of the learners.

9. *Revise Instruction.* The support that the model offers for this phase consist in strategies for analyzing the data collected during formative evaluation (by group/by learner, single item/across tests, etc.). The results can then be merged in the instructional analysis diagram in order to see what goals have been satisfactorily achieved and if there are eventual skill gaps. This process results in an indication of what elements of the strategy or of the materials or of the instructor activity could be improved. Notice that, as education is a complex event, no definite indication of improvement can be considered certain. While the instructor is committed do her/his best for achieving the results, the interaction among the participants – which is the core of education – is unpredictable: a bad day of a class leader can spoil even the best, revised and tested activity.
10. *Design and Conduct Summative Evaluation.* Summative evaluation is the “process of collecting data and information in order to make decisions about the acquisition or continued use of some instruction” (Dick, Carey & Carey 2001, p. 349). In other words, it is a measure of the effectiveness and efficiency of the instruction from the stakeholders’ point of view. The model proposes to structure it into two main phases: expert judgment and field trial.
  - a. The expert judgment phase should evaluate the congruence of the instruction with the organization’s needs and resources; evaluate content, design, feasibility and an analysis of the current users.
  - b. The field trial phase should provide a test case for evaluating the actual outcomes.

Summative evaluation is a final consideration of the overall quality of the instruction not *per se*, but in relation to the organizational context for which it was created.

The Dick, Carey and Carey model is a complex model, developed with the aim of guiding the instructional designer in considering a great number of elements in a structured way. Mastery in such a process clearly defines a specific professional profile, remarkably different from the teacher. The complexity of the design and development process shows the high number of interdisciplinary interactions that the instructional designer should be able to manage, and at the same time the quantity of documentation necessary to keep track of the process and to allow revision, consistency checks and backward feedback from one phase to each other.

The overall impression that this model may leave is that the design of instruction can be turned into a very structured and partially automatic process, where an expert system may have not negligible success chances. It is likely that this model let arise a question: does the design of a human-rich experience as education actually benefit from such a rigid structure? Is it not rather hindered by it? The good of this model is that it is a conceptual one: it provides a structured reference for thinking about design in a comprehensive way. On the other hand, real design is usually more hectic than linear. The next three models can be considered as a possible reaction to this approach.

### *Smith & Ragan’s Instructional Design*

Smith and Ragan’s *Instructional Design* (1999) is a noteworthy text as it dares to move one step beyond the usual boundaries of the discipline.

As the reader will have noticed, all the models presented up to now are focused on two of the three layers proposed by Richards and Rodger, namely design and procedures. Classical Instructional Design models are concerned with the process that gives shape to instruction in its overall form (design) and in how to implement it in real activities and tools (procedures). Smith & Ragan do not propose neither an innovative design model, nor new instructional techniques, but introduce a powerful insight: the way which we design education is strictly bound to our idea of education and of the subject matter. Instructional Design tools are actually exploited by designers according to their position and beliefs on the approach layer. Smith & Ragan focus their attention the influence of educational principles on design rather than on procedures, keeping a practical theoretical eclecticism. From a technical standpoint, they assume the Dick, Carey and Carey model as general framework, integrated with other contributions and with their own experience. For this reason this work does not

include a complete presentation of the model's phases. The interesting focus and original contribution is rather on instructional strategies for the achievement of different types of learning goals.

### Philosophy and Theories

The key element for understanding this approach to Instructional Design is the distinction between educational philosophy and learning and instructional theories.

Smith and Ragan introduce the subject by stating that

*Fields of study, such as instructional design, do not have educational philosophies; people who study in these fields do.*

(Smith & Ragan 1999, p. 14).

An educational philosophy is a general view of education defining its main elements and processes. Long to have a direct influence on the way we design and perform instruction, educational philosophies provide a certain understanding of the general terms in the field. Constructivism is presented as the most *à la page* example of educational philosophy, along with empiricism and rationalism.

On the other end of the dichotomy there are theories, “an organized set of statements that allow us to explain, predict and control events” (Smith & Ragan 1999, p. 18). Learning theories usually belong to the category of descriptive theories (i.e. explain how learning happens), while instructional theories to that of prescriptive theories (i.e. prescribe actions to take that will lead to certain results). The action guidance principles that a theory provides are the key factors for the instructional design process, and real differences can be appreciated only on this level. The specific moment within the design process where such differences can be observed is the definition of an instructional strategy.

One example is the discussion of generative and supplantive strategies. The issue could be expressed as the dilemma between how much a strategy should let the learners do the job by themselves, stimulating them and letting them construct their own knowledge (generative), or how much should the instructor take the lead and provide support to the learners (supplantive). The general principle outlined is that learning is an intentional activity that only the learner can perform; consequently, the more the learners are put into action, the better it is. On the other side, a number of both practical (feasibility, such as limited time) and cognitive (such as high anxiety or low aptitude) issues are presented that may let us prefer a supplantive strategy. Smith and Ragan propose a summary of the discussion in two points (Smith & Ragan 1999, p. 126):

1. An optimal instructional strategy goes as far toward the generative pole as possible while providing sufficient support for learners to achieve learning in the time possible, with a limited and acceptable amount of frustration, anxiety and danger.
2. During instruction in a particular knowledge area/learning task, the instruction should progressively move toward the generative pole, as learners gain skill, knowledge, motivation and confidence.

Leaving ideology apart, principles are the motives that guide designers. Tools and techniques will be accordingly selected and used.

### Instructional Strategies

The greatest part of Smith & Ragan's work is devoted to the presentation of instructional strategies for achieving different learning outcomes. A strategy is defined as a plan for action including three main dimensions:

1. Organization: the structure and clustering of content.
2. Delivery: the media involved in the delivery, and the specific tools designed for that.
3. Management: the organization of the learning activity into a unitary schedule.

The learning objectives for which strategies are presented are taken from Gagné's taxonomy (introduced in detail later on)<sup>10</sup>: problem solving; declarative knowledge; concept learning; principle learning; procedures learning; cognitive strategies; attitude change, motivation and interest; psychomotor skill.

Smith and Ragan outline strategies first by addressing the cognitive processes at work for the specific kind of learning objective, and then providing details about the phases that the instruction should go through in order to achieve them. Gagné's Nine Events of Instruction (grouped and refined into four main steps: introduction, body, conclusion and assessment) are the backbone of their approach. Moreover, particular insights on critical details of sub-strategies are presented. The text also provides a great number of examples that embody the principles presented, along with accurate references.

It might be interesting to draw a short comparison about the idea of instructional strategy as proposed by different authors. While all of them understand *strategy* as the holistic principle of the educational environment, they propose different description of what should be in a strategy.

Dick, Carey and Carey, as was presented above, say that a strategy is the delivery system, the content (sequencing and clustering), the single activities (including student groupings and media), all related with the objectives for the instruction. They view, like Smith and Ragan's, strictly considers the design layer; on the other hand, they describe a strategy "from within", while Smith and Ragan also consider the process requires for letting the instruction work, and also consider the management part.

(Olivier 2002) proposed another view, where a strategy is the definition of activities, support (or communication opportunities) and resources. This definition does not include content, and is probably to idealistic in its claim of completely content-independent strategies. On the other side it has the advantage of clearly pointing out the definition of communication dynamics within the learning environment, thus directly addressing the issue of interaction among the players.

Another view of a strategy is proposed by Cantoni and Di Blas (2002), especially for the introduction of new media in education, and it includes the definition of the use of time (synchronous vs. asynchronous), the use of space (distance vs. face-to-face), grouping criteria, support and the interplay between different technologies and tools. This view is more general and less design-oriented, but can be a useful framework for moving from the approach layer to the design one.

In conclusion, Smith and Ragan's *Instructional Design* summarizes a number of prior contributions from the original and interesting perspective of principles and strategies. This means introducing a new way of teaching Instructional Design, as well as stressing the professional importance of a general understanding of education also in a technically oriented job as design is.

#### *Greer's Instructional Design Project Management*

Michael Greer's *ID Project Management* (Greer 1992; seminal work in Greer 1991) presents the design process from the manager's perspective, which should cope not only with learning and pedagogy, but also with scarce resources, limited time and budgeted costs.

*Like any manager, the ID project manager must complete projects within limited budgets and schedules. Yet good instructional design and development principles often collide with these 'bottom-line' constraints. ID project managers must therefore walk a tightrope, suspended between their own ID conscience and their management's requirements for fast, cost-effective training. (...) To be effective, a good project manager must be able to perform exactly the right management interventions at exactly the right times.*

(From [www.michaelgreer.com](http://www.michaelgreer.com), August 2003)

The result is the embodiment of general models into the complicate, multi-faceted and partially non-rational world of human decisions. If through the filters of structured models and box diagrams education may have seemed a little bit more like a science, Greer reminds us that it has to do with having things done, with putting the right people together and finding effective and efficient solutions

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<sup>10</sup> In addition to these, Smith and Ragan include some concluding remarks about the development of delivery and management strategies and about macro strategies (i.e. concerning more goals of different types).

through analysis, creativity and a certain degree of compromise. Indeed, many authors (such as Back & Bursian 2003), report that the organizational aspects of education and eLearning still present a number of open issues. Teaching and learning are in fact human activities and as such must deal with people and resources in the organization within which they take place. Although these issues will not be overtly considered here, they form the natural background of this work.

This concern brings to a new arrangement of the standard instructional design phases as presented by Dick, Carey and Carey into ten steps. Each step includes a set of decisions to be taken, of actions to be completed and outputs to be produced. For each step Greer provides methods and tools for the activities (checklists, worksheets, guidelines, etc.). Figure 1.12 presents an overview sketch of the model, grouped into three main phases:

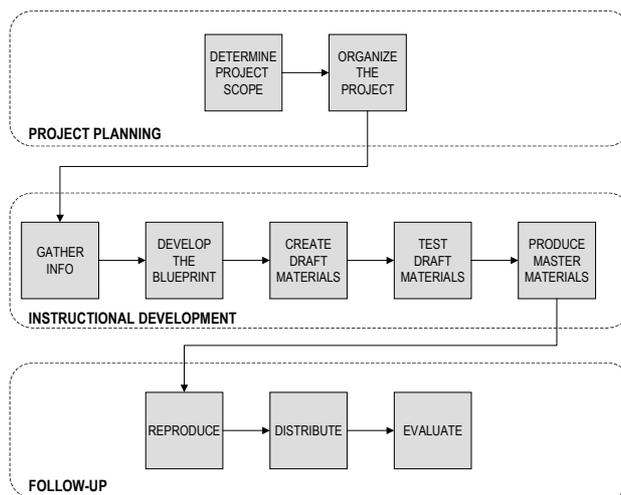


Figure 1.12 - Greer's model

Just like other models, this model assumes that all necessary front-end analysis has been completed, and that training was identified as the best solution. The following paragraphs introduce each phase and step in more detail<sup>11</sup>.

### Phase I: Project Planning

The first phase, which comprehends two steps, concerns the preparation of the project, its planning and start.

1. *Determine Project Scope:* When selling a project to internal or external sponsors, it is important for the project manager to make a preliminary guess at the project scope. This provides a reality check, allowing everyone concerned to affirm her/his commitment to the project and its scope.
  - a. Activities: make an early estimate of the amount of materials that must be created, the time and effort required to create them, and the resources required.
  - b. Results: preliminary materials specifications; project schedule and/or time estimate; budget and/or cost estimate.
2. *Organize the Project:* It is likely that substantial time will pass between the time the project scope is determined (as in Step 1) and the time that the project is authorized to begin. Therefore, the actual management of a project begins with this step, which requires the manager to confirm that the assumptions made about the project scope are still valid. In addition, it requires that detailed plans be developed, thus helping to lay the groundwork for a successful project.
  - a. Activities: Confirm earlier assumptions about preliminary materials specifications, time, and costs. Confirm the project team members. Set up the project diary and organize the kickoff meeting.

<sup>11</sup> This presentation of Greer's mode was adapted from <http://www.michaelgreer.com/idpm-mdl.htm>, August 2003.

- b. Results: A revised or confirmed set of materials specifications, schedule, and budget. List of project team members with the corresponding roles. Project diary containing important project data. A well-organized kickoff meeting.

Interesting guidelines are provided here concerning the selection of persons and roles for the development team, which is indeed an often-overlooked success factor.

### Phase II: Instructional Development

The actual design and development phase, more or less corresponding to the Dick, Carey and Carey model, is reproduced in Greer's Phase II, which includes 5 steps.

3. *Gather Information:* Step 3 corresponds to the familiar "requirements analysis". From a (maybe "commercially-extreme" but relevant) managerial perspective, information gathering assures that the training provides the right skills and concepts and that "training dollars are invested wisely".
  - a. Activities: First, determine what kind of information is needed to support instructional development (here, the learner and learning and performance context guidelines from previous models could be integrated). Then, through observations, interviews, and review of documentation, collect information. Formal task, job, or content analyses may be also conducted.
  - b. Results: Detailed information concerning:
    1. The target audience of the training.
    2. The trainees' relevant work environment.
    3. The specific tasks that must be learned.
    4. Technical details about the course content.
4. *Develop the Blueprint:* The blueprint is a set of design specifications that allows all relevant reviewers to look at course content and strategy before energy and resources are actually expended for material development, testing and course implementation. This early review permits the design team to make substantive structural revisions while the course is still easily revisable.
  - a. Activities: Synthesize the information gathered in Step 3 and create a detailed description (the blueprint) of the courseware to be developed. Share the blueprint with reviewers and revise based upon their comments.
  - b. Results: A blueprint document that includes the following parts:
    1. A big picture description of the instructional materials and course flow.
    2. Specific performance objectives.
    3. Specific instructional strategies to be employed to attain each objective.
    4. A detailed outline of content to be included in support of each objective.
    5. A summary of media and materials to be created to support each objective.
    6. Formal approval of the blueprint by the course sponsor.
5. *Create Draft Materials:* this is the first step concerned with material development. Interestingly, where other models just present one phase for this activity, implying that test and revisions are done, Greer proposes three distinct steps (four including the final reproduction step in the next phase). This fact underlines that material development, despite not the most deciding activity in terms of final quality, is probably the most expensive activity in the whole process. Moreover, it is as well a delicate one as it requires tight interdisciplinary work. In Step 5, draft versions of all instructional materials should be created before expensive master materials are produced. These materials will then be reviewed, revised, tested, and finalized before production begins.
  - a. Activities: Create drafts of workbooks, job aids, lesson plans, media scripts, Web applications, multimedia materials, and any other materials. Review these with subject matter experts and other members of the design team, then revise as needed.
  - b. Results: Preliminary and revised drafts of all materials. Formal approval of drafts by the course sponsor.
6. *Test Draft Materials:* after test materials have been created, a test run of the course is essential to make sure that the materials work as expected.
  - a. Activities: Assemble representative members of the target audience and test the draft materials while observing their performance. After the test, debrief trainees and observers

- and specify revisions. Review test results and revision specifications with the course sponsor.
- b. Results: Test run of all courseware. Detailed revision specifications, approved by the course sponsor.
7. *Produce Master Materials*: the purpose of this step is to create professional quality masters of all course materials to be exploited for real course editions.
- a. Activities: Produce final masters of print, audio, video, Web, multimedia, and any other materials.
  - b. Results: High-quality master materials that may be used to create correspondingly high-quality reproductions. Formal approval of these masters by the course sponsor.

### Phase III: Follow Up

The final phase considers three activities that bring the instruction from project to reality.

8. *Reproduce*: This step considers making copies of all materials prior to distribution to trainees and instructors.
  - a. Activities: Reproduce all course materials in specified volumes.
  - b. Results: High-quality copies of all course materials, as defined by the design specifications.
9. *Distribute*: the purpose of this step is to make sure that all materials are properly stored and/or disseminated for the instruction to take place.
  - a. Activities: Distribute copies of materials to the appropriate locations for storage and/or dissemination to trainees and instructors.
  - b. Results: Copies of materials, properly stored and distributed in a timely manner.
10. *Evaluate*: according to Greer, the main purpose of evaluation is to determine the long-term effectiveness of the instructional materials that were created. A secondary purpose is to confirm that the assumptions made about effective instructional design strategies continue to remain valid.
  - a. Activities: After trainees complete the course, conduct follow-up analyses of their ability to perform skills on the job. Develop recommended revisions based on these analyses.
  - b. Results: Reports of trainee skill level after completing the training. Recommendations for revisions and recommendations for improving the instructional development process.

It is interesting to notice two features that make this model different from the more academic Instructional Design tradition.

First of all, the stress is on materials, yet not from a technical point of view, such as in product-oriented models. The point here is not how to design and produce them, but how to manage the production process. This stress depends on the fact that material production (or even selection), reproduction and distribution is one of the major expenses – and this is even truer when considering eLearning. The presence of steps concerning reproduction and distribution is also an indicator that the model is action-minded, and that it wishes not just to *design* education, but actually implement it. Reproduction and distribution are in fact non-creative tasks, instrumentally related to education (and this is why they are not considered by other models), nevertheless necessary and, if badly managed, may cause even the best program to fail.

Secondly, all the steps in which decisions have to be taken (namely step 4 to 7) are concluded with “getting the sponsor’s formal approval”. This introduces another relevant issue, underestimated by models that do not take care of the organizational dimension of education: any program has stakeholders. A stakeholder is someone who is interested in the instruction to take place, and ultimately in the learners to achieve the goals – finally, someone who provides the financial means. Clearly, in the larger number of instances, this is not the learners, but the State Department of Education, the Company’s boss, the Dean, etc. It is a person (or entity) traditionally outside the design process, as it is neither an actor in it, nor in the instruction. Nevertheless, stakeholders do not only provide the first input and the money: they are the ones deciding about the life of a program, and they are the ones who should be in the end satisfied with the designers’ work<sup>12</sup>.

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<sup>12</sup> Another perspective from which the role of stakeholder becomes relevant is the evaluation of education, as argued by Eppler & Mickeler (2003).

### The "Oval Model"

Before shifting our attention to the technology world, another design model, developed by Morrison, Ross and Kemp through the editions of their book *Designing Effective Instruction* (2003) deserves some attention. This model is practice-oriented, and was developed by tailoring the conceptual modeling achieved by other authors to the real practice of instructional design.

Morrison, Ross and Kemp define any instructional design project as a field in which four main elements interact: the learners, the methods used for the instruction, the objectives for the instruction and the evaluation. The four of them should be considered simultaneously, given the tight interdependencies that exist among them. The design model they develop is different from the ones presented above, as it is not sequential and cyclic, rather includes nine interconnected components (see Figure 1.13).

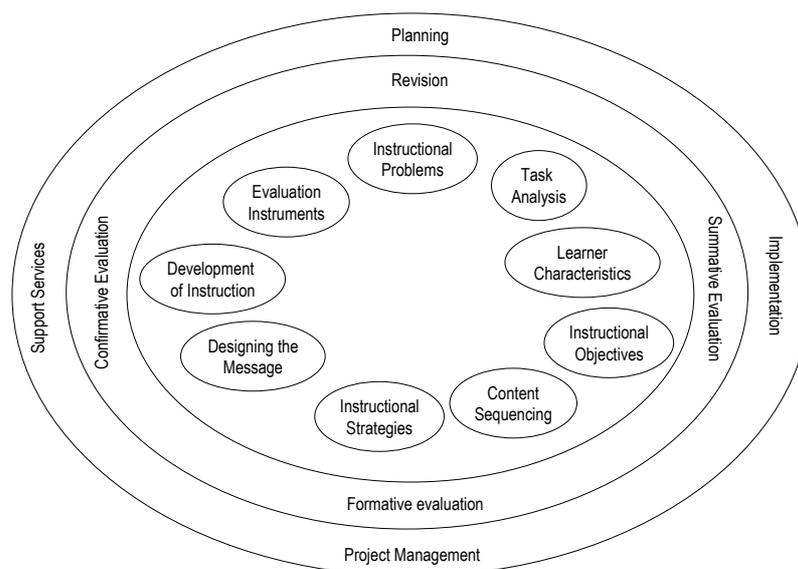


Figure 1.13 - The "oval model"

The inner circle contains the nine elements of the design process. The external circle defines the areas that the process goes through (planning, implementation, project management and support services – in a non sequential fashion), while the middle circle focuses on the evaluation process.

The nine elements, taken one by one, do not present great novelty with respect to the models previously described, except maybe for positioning *content sequencing* as a stand-alone element outside *instructional strategy*, and *designing the message* outside *development of instruction*. The real novelty lies in the overall structure.

*The elements are not connected with lines or arrows. Connections could indicate a sequence, linear order. The intent is to convey flexibility, yet some order in the way the nine elements may be used. Also some instance may not require treating all nine elements. (...) Another reason for using the oval form is that flexible interdependency exists among the nine elements.*

(Morrison, Ross & Kemp, p.8)

The elements, or components, are therefore not stages, levels or steps, and the result is a flexible and loose model, that help designers to focus on relevant issues without wasting time in fulfilling the “needs of the model” rather than solving the real instructional problem. The idea is that the design process is actually heuristic, and should be adapted by each designer to the constraints and context of the project.

The practice-orientedness of this model is also revealed in the attention the authors pay to approaching Instructional Design as the description of a job, rather than as a set of principles. Emphasis is put on project management, on the interaction with the instructor and the subject-matter expert and on the role of stakeholders and “clients” in the different contexts of education, business and in the perspective of a professional instructional design consultancy company. The development of a course is therefore framed in the context of the organization developing it, as a process of planned change.

A last remark is deserved for the three types or moments of evaluation: formative and summative evaluations (improvement of the instruction and general achievement of goals, respectively) were already presented in the Dick, Carey & Carey model above; here, *confirmative evaluation* is added. The idea is that continuous evaluation should be done while the program is running, from one edition to the following, in order to see if the instruction still meets the needs it was developed for, or if the problem has changed and the instruction should be accordingly redesigned.

This model, for its flexibility and heuristic nature more respondent to the practice of instructional design, will be taken as main reference in the further development of this work.

### *IMS Learning Design*

On February 14<sup>th</sup>, 2003 the mailing list of Learning Networks announced that IMS approved the final version of the Learning Design specification, based on the work carried out at the Open University of the Netherlands (OUNL) in the field of educational modeling and on a specification called EML – Educational Modeling Language. (Knebel & de Vries 2003; for EML see Koper 2002a, Koper 2002b). This was indeed a great leap forward for both involved organizations: OUNL finally was given an official recognition of its year-lasting effort in developing EML; IMS released a framework within which the use of Learning Objects acquires a new perspective.

EML was a conceptual language for describing instruction, and was released along with the corresponding XML binding. OUNL also developed Edubox, a core implementation of a Learning Management System exploiting EML. While Learning Objects standards concern the development of learning materials, EML proposed the same technologies for describing the educational activity *as such*. EML was a formal language (or more precisely a defined vocabulary of XML) for expressing the roles, activities and interactions of an educational environment.

IMS included EML in its new release, Learning Design v.1.0 (IMS 2003a), and developed a unified framework for representing educational environments. Learning Design is clearly fully integrated with other IMS specifications, such as the Learning Object Standard (IMS 2003d), the Learner Information Package (IMS 2003f) and the Reusable Definition of Competency or Learning Objective (IMS 2003g). With Learning Design IMS completes a suite of formal tools that potentially encompasses the whole activity of the instructional designer.

This is the reason why the Learning Design specification is among system-oriented models, while the Learning Objects one is among product-oriented models. While the latter concerns tools that could be exploited in education, the former aims at representing the whole instruction.

### Relevant issues for Learning Design

The specific issues IMS is trying to tackle are the following:

*The development of a framework that supports pedagogical diversity and innovation, while promoting the exchange and interoperability of learning materials, is one of the key challenges in the e-learning industry today. The absence of agreed and compatible ways to describe teaching strategies (pedagogical approaches) and educational goals is a constraint that will hold back the development of the industry. There are consequences of not delivering such a framework. Creators of teaching materials and their organization will continue to experience unnecessary difficulty in (a) documenting the teaching strategies used with those materials; (b) establishing and adhering to prescribed procedures for assuring consistency of that documentation; (c) ensuring that teaching quality targets are met across or between organizations; (...).*

(IMS 2003a, Best practice guide, p. 4)

Interestingly, these goals match almost perfectly this very work's goals, and correspond to the main issues for E<sup>2</sup>ML. Later on, IMS Learning Design and E<sup>2</sup>ML will be compared in detail, but it is worth noticing that the main perspective is different: while IMS chose the way of formal machine-readable code expression, E<sup>2</sup>ML proposes a more lightweight visual and human-readable format. Consistently with the Learning Object metadata initiative, IMS indeed aims at machine readable tagging of instructional content and units, in order to allow semi-automatic cataloguing, free-text search in repositories, adaptive exploitation of content, etc. End users are human, but always mediated by a machine, both for writing metadata and for using them.

#### Objectives of Learning Design Specification

The objective of the Learning Design Specification is therefore providing a framework that formally describes any element or feature of a teaching-learning process. More specifically, the Learning Design Specification meets the following requirements (IMS 2003a, information model):

1. *Completeness*: The specification must be able to fully describe the teaching-learning process in a unit of learning, including references to the digital and non-digital learning objects and services needed during the process. This includes:
  - a. Integration of the activities of both learners and staff members.
  - b. Integration of resources and services used during learning.
  - c. Support for a wide variety of approaches to learning.
  - d. Support for both single and multiple user models of learning.
  - e. Support mixed mode (blended learning) as well as pure online learning.
2. *Pedagogical Flexibility*: The specification must be able to express the pedagogical meaning and functionality of the different data elements within the context of a unit of learning. It must be flexible in the description of all different kinds of pedagogies and not prescribe any specific pedagogical approach.
3. *Personalization*: The specification must be able to describe personalization aspects within a learning design, so that the content and activities within a unit of learning can be adapted based on the preferences, portfolio, previous knowledge, educational needs, and situational circumstances of users. In addition, the control over the adaptation process must be given, as desired, to the student, a staff member, the computer, and/or the designer.
4. *Formalization*: The specification must describe a learning design in the context of a unit of learning in a formal way, so that automatic processing is possible.
5. *Reproducibility*: The specification must describe the learning design abstracted in such a way that repeated execution in different settings with different persons is possible.
6. *Interoperability*: The specification must support interoperability of learning designs.
7. *Compatibility*: The specification uses available standards and specifications where possible, mainly IMS Content Packaging, IMS Question and Test Interoperability, IMS/LOM Meta-Data and IMS Simple Sequencing.
8. *Reusability*: The specification must make it possible to identify, isolate, de-contextualize and exchange useful learning artefacts, and to re-use these in other contexts.

### Learning Design Information Model<sup>13</sup>

As all IMS specifications, Learning Design comes with three main documents: the Information Model, the XML Binding and the Best Practice and Implementation Guide. For the purpose of this work, a presentation of the Information Model would be enough in order to grasp the structure of Learning Design and its implications for Instructional Design.

The UML representation of the Information Model is reported in Figure 1.14.

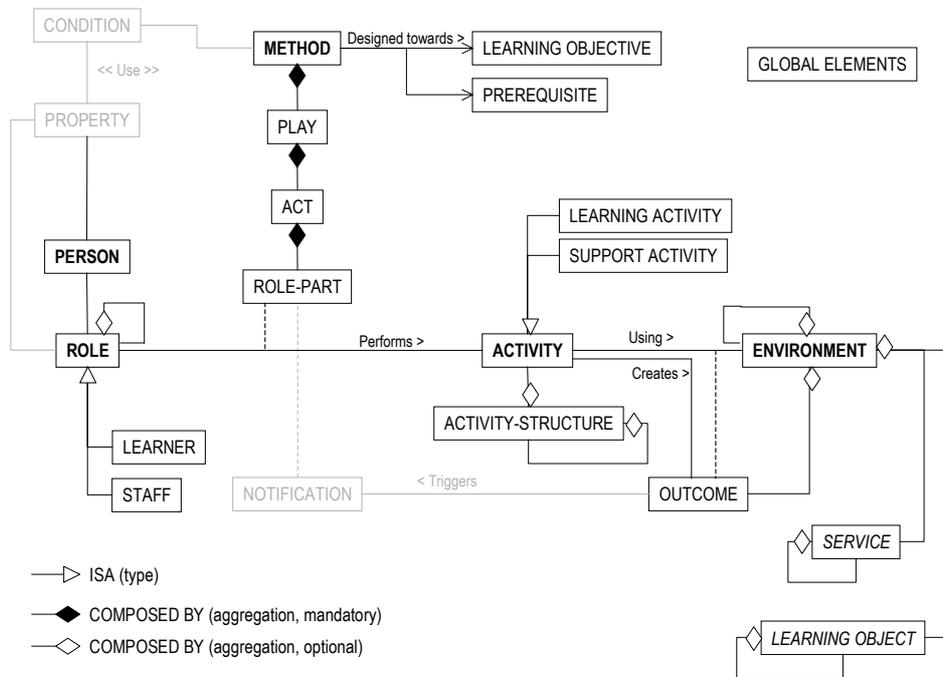


Figure 1.14 - IMS Learning Design Information Model (UML)

Bold names identify the core entities in the model. Cardinality was omitted in order to improve legibility. The model defines three levels: the core level (A), and two additional levels defining property and conditions (B) and notification (C). Strict compliance is relative only to level A (gray boxes represent level B and C entities).

The core concept of the Learning Design Specification is that regardless of pedagogical approach, a *person* gets a *role* in the teaching-learning process, typically a *learner* or a *staff* role. In this role s/he works toward certain *outcomes* by performing more or less structured *learning* and/or *support activities* within an *environment*. The environment consists of the appropriate *learning objects and services* to be used during the performance of the activities. Which role gets which activities at what moment in the process, is determined by the *method* or by a *notification*<sup>14</sup>.

The *method* is designed to meet *learning objectives* (specification of the outcomes for learners), and presupposes certain *prerequisites* (specification of the entry level for learners). The method consists of one or more concurrent *play(s)*; a play consists of one or more sequential *act(s)* and an act is related to one or more concurrent *role-part(s)*, each role-part associates exactly one role with one activity or activity-structure. The teaching-learning process is modelled in the method on the notion of a theatrical play. A play has acts, and in each act has one or more role-parts. The acts in a play follow each other in a sequence (although more complex sequencing behaviour can take place within an act). The role-parts within an act associate each role with an activity. The activity in turn describes what that role is to do and what environment is available to it within the act. In the analogy, the assigned

<sup>13</sup> This part was adapted from (IMSa 2003, information model).

<sup>14</sup> Most of the concepts mentioned above are reflected in the information model, but some only exist at the conceptual level (person, outcome).

activity is the equivalent of the script for the part that the role plays in the act, although less prescriptive. Where there is more than one role-part within an act, these are run in parallel<sup>15</sup>.

The explicit *roles* specified in this language are those of *learner* and *staff* roles. Each of these can be specialized into sub-roles, but no vocabulary is put forward for this. It is left open to the learning designer to name the (sub)-roles and specify their activities. For example, in simulations and games different learners can play different roles, each performing different activities in different environments.

*Activities* can be assembled into *activity-structures*. An activity-structure aggregates a set of related activities into a single structure, which can be associated to a role in a role-part. A structure can model a sequence or a selection of activities. In a *sequence*, a role has to complete the different activities in the structure in the order provided. In a *selection*, a role may select a given number of activities from the set provided in the activity-structure. This can, for instance, be used to model situations where students have to complete two activities, which they may freely select from a collection of e.g., five activities contained in the activity-structure. Activity-structures can also reference other Activity-structures and reference external Units of Learning, enabling elaborate structures to be defined if required.

Finally, *environments* can contain two basic types:

1. Located *learning objects*, typically specified by a URL with optional metadata. A user may further classify these learning objects by means of the vocabulary provided in the IMS LOM Meta-Data or the generic 'class' attribute that is available on all elements. In EML, the learning objects are classified in the following types: knowledge-objects, tool-objects, and test-objects.
2. Generic *services*. A service relates to a concrete service facility available at runtime. During design a service has no URL assigned to it, but must be given a URL when the Learning Design is instantiated at runtime. Examples of a Service include a discussion forum, chat rooms, monitoring tools, search facilities, etc. In Learning Design the conditions for setting up a service at runtime are specified at an abstract level. For example, for discussion groups it specifies which learning design roles have what type of access (participant, observer, moderator, etc.).

For each of the elements presented here synthetically, a specific description is then provided in the Information Model, along with the corresponding XML representation in the XML Binding document.

### Who uses Learning Design?

While the issue was self-evident for Learning Objects (the developers tag Learning Objects and make them searchable in some repository, reusable and adaptable), it deserves a little space in the present case. The idea is that instructional designers in large organizations use Learning Design for:

1. Documenting the design process in order to share it with the rest of the team.
2. Documenting the design process in order to reuse (eventually adapt) the instruction.
3. Configuring the Learning Management System (clearly, if it is Learning Design compliant) through representing the instruction in XML.
4. Documenting the design process in a standard way in order to make it understandable by external designers and comparable to other designs.

It is nevertheless still unclear who will be actually writing the XML code. XML is not a standard part of the instructional designer's curriculum, and having a person developing the XML code for each course would be extremely costly. The real issue for the next years (and this is the intention of IMS as

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<sup>15</sup> A method may, at level B, contain conditions (i.e., If-Then-Else rules that further refine the visibility of activities and environment entities for persons and roles), by defining Boolean expressions on their properties. A property can be grouped into property-groups. Properties can be of different types, representing respectively global versus local properties and personal versus role properties. In order to enable users to set and view the level B properties from content that is presented to them, so-called global elements are present in the model. These global elements are designed to be included in any content schema through namespaces. A notification is triggered by an outcome and can make a new activity available for a role to perform. The person getting the notification is not necessarily the same person who creates the outcome. For instance, when one student completes an activity (= an outcome), then another student or the teacher may be notified and set another activity as a consequence. This mechanism can also be used for learning designs where the supply of a consequent activity may be dependent on the kind of outcome of previous activities (adaptive task setting designs).

a standardization organization) is the development of applications that make the exploitation of these standards simple and effective. A motivator for the effective introduction of Learning Design into the design practice would be the existence of affordable IMS-compliant Learning Management Systems, along with applications that support the production of metadata.

## Summary

This forcedly short review of Instructional Design models provided a general understanding of the main elements in the design process along with some techniques for each sub-activity. Generally speaking, all models share a general stepwise approach to instructional design, which can be summarized in five major activities: analysis, design, development, evaluation and revision. Secondly, several components can be identified within any activity: specific procedures (e.g. Landamatics), events that foster learning (Gagné) and motivation (e.g. ARCS).

While ADDIE provided the main structure for the design process, each classroom-oriented model provided a specific insight: ASSURE focused on material development, ARCS pointed out the importance of motivational issues, and Landamatics proposed a structured approach to procedure learning. The comparison of the selected system-oriented models allowed the identification of different approaches: one more rigid and stepwise (the Dick, Carey & Carey model), the other more flexible (the oval model), a third one emphasizing principles and strategies (Smith & Ragan's), and a fourth dealing with management issues (Greer's). Product-oriented models illustrated a more traditional design approach to material development, and a more recent trend of learning objects. The latter was recently extended to system-level with IMS Learning Design.

A basic concern that will not be further developed here can be formulated as a question: is a structured design approach beneficial for education? If the answer is positive, then this work and E<sup>2</sup>ML might be considered of interest. I believe that in a number of situations, such as the ones described in the Introduction, it is a necessity: improvisation and creativity alone cannot cope with too complex settings – they need a structure to survive and to produce quality instruction.

Before coming to the core part of this work with the introduction of E<sup>2</sup>ML, the following pages will offer a sort of zoom into the most deciding and tricky of design phases: the definition and expression of learning goals.

## Expressing Learning Goals

*Educational goals are statements of the outcomes of education.*

(Gagné 1992, p. 41)

The statement of the learning objectives is one of the most important and deciding moment of the design process, as they are like a compass indicating the desired destination, the expected final outcome of the educational activity.

When an architect designs an apartment, he can control the whole process and also the actual construction (excluded cost constraints or other external limitations): if the owner in the end is not satisfied, this should be imputed to a misunderstanding in the requirement analysis – the architect's image of the final result was not the same as the owner's. The situation is more complicated in education. First, where there was only one owner, there is a stakeholder (a boss who wants his employee to be trained) and more learners (who would like anything but a training session...). Moreover, given that the goals are correct and correspond to the learners' and stakeholders' expectations, their achievement is a result of the interaction between the planned educational activity and the learners, and is not completely up to the designer's will and competence. But let's go one step

further: differently from other design activities, learning objectives are not easy to express as they concern mental states, non-observable events (at least directly).

These are some reasons why learning goals are one of the major topics in Instructional Design. Classifying goals and matching them to instructional strategies is indeed the most difficult step in the whole design process. Here is where instructional theories are brought in, and where the designer's idea of education becomes deciding. The last part of this Chapter will therefore be devoted to this particular phase of the design process<sup>16</sup>.

As pointed out with ASSURE, most of the literature distinguishes between *goals*, i.e. high-level descriptions of the expected outcomes as competencies remaining after learning is concluded, and *objectives*, i.e. more detailed abilities that should be tested at the end of the instruction. The following pages will not follow these definitions strictly, and the two terms will be used almost interchangeably. This review is forcedly limited and does not take into account all relevant literature on the topic. For an updated and more exhaustive review and a comparison among models the text by Anderson and Krathwohl (2001) is the most recent and complete. The idea here is rather to propose an interpretative key that later supports E<sup>2</sup>ML proposal of a specific new tool for learning goals classification, the QUAIL model.

## What is an Objective?

The general definition of *learning objective* is likely to be the only shared point among all the authors that dealt with the issue. A learning objective is the formulation of the expected outcome of the instruction in terms of acquired knowledge and competencies.

A correct formulation of an objective should take the learner perspective (“be able to draw pie-charts”), leaving aside the instructor's perspective (“show students how to draw pie-charts”) and the activity perspective (“discuss some pie-charts with the students and let them work on a small data set on their own”). An objective should therefore describe the desired final status of the learner with respect to the changes developed during the learning activity (Gronlund 1995).

## Objectives and Behavioral Objectives

The topic of how objectives should be expressed once they have been located within a defined taxonomy deserves some short remarks.

Goals, intended as general expected outcomes, do not present particular issues. Valid goals could be “Understand the main feature of the XIX Century novel” or “Solve arithmetic expressions”. The issue rises when we come to expressing objectives. The point is that objectives should be used for learning assessment, and should be therefore related to something observable. The idea of behavioral objective (or performance objective) is a possible solution to the fact that learning is something by nature directly unobservable. A part of the Instructional Design tradition is therefore oriented at expressing goals in terms of quantifiable and measurable outcomes: “Learn what a sample population is” would be therefore refined into “Define verbally what a sample population is” or “Given a problem and a survey, propose a significant sample population”. This would allow a better definition of test items – recall that in the Dick, Carey & Carey model, the definition of test items comes right after the analysis and goal definition steps.

The very idea of behavioral objectives was expressed by Mager (1962). Yelon (1991) wrote a complete and straightforward account of the behavioral objectives theory in which he addresses three main issues, which are presented in the following paragraphs. The first two of them concern the expression of goals and objectives in general, and will serve as basis also for the development of the QUAIL model in Chapter II; the third one is specific of behavioral objectives, and will be discussed in the fourth paragraph, reporting some critics by Merrill.

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<sup>16</sup> We deal here with the expression and classification of learning goals. As we have seen, some design models (e.g. the Dick, Carey & Carey model) include tools for the breakdown analysis of learning goals, in order to identify relevant sub-skills and eventual entry competencies. This second issue is not addressed here, as it includes a number of other issues.

### *Why Using Objectives*

Expressing objectives is indeed an additional time-demanding work for instructors and designers, so what are the advantages of having them written down? Yelon identifies four reasons:

1. For planning the instruction: all models require goal definition in order to design an instructional strategy, the learning assessment and the evaluation of the instruction. In case more instructors are collaborating in one course, the explicit definition of goals may also help making the instruction consistent.
2. For communicating intent to students: goals are a medium that can make students aware of what is going on in the instruction, thus creating correct expectations and helping to focus on relevant features.
3. For motivating: goals are motivation factors, as they create a tension toward a sort of final achievement. From this perspective short-term and long-term goals (see below) can play different roles, the former being more motivating yet more particular, the latter being less motivating but more general.
4. For justifying what is taught: the definition of goals is a key element for making instruction accountable, in terms of content selected, organization, resources spent, and final achievements.

These reasons for explicitly expressing objectives are underlying the definition of the QUAIL model as part of the E<sup>2</sup>ML specification.

### *Types of Objectives*

Objectives are not all of the same type, as they depend on the kind of knowledge or competence being learned. The models introduced below provide a more detailed discussion about this topic.

Yelon introduces some other functional distinction concerning the relation of each single objective to the instruction:

1. Terminal vs. enabling: terminal goals are the goals at which the instruction is actually aimed; for being achieved, they may require the achievement of other intermediate goals that enable the final ones.
2. Easy vs. difficult: depending on the learners (as a class, or individually), objectives may have a different degree of difficulty.
3. Course vs. lecture: objectives may be related to a single lecture, class or activity in which they are supposedly achieved, or may have the scope of the whole instruction.
4. General vs. specific: objectives may concern a broad range of disciplines or topics (such as “be critical”), or may be specific to a subject matter (“use the element table”).
5. Simple vs. complex: objectives may be of one type (factual knowledge such as “know that water is H<sub>2</sub>O”), or may combine knowledge of different types, such as in a typical problem-solving task<sup>17</sup>.
6. Short-term vs. long-term: although not addressed directly in Yelon’s paper, a clear distinction should be made between goals that will be achieved, and will be observable, in a short time, and goals that require a longer time, maybe beyond the limits of the instruction.

### *Expressing Objectives*

While the first two issues mentioned above may be related to all kinds of objectives, behavioral or not, the final concern of Yelon’s – how to express them – explicitly relates to the behavioral paradigm. The general schema of a *valid* objective should be:

1. What is to be learnt in term of observable performance.
2. Under what conditions it should be performed.
3. With what degree of mastery.
4. With what tools.

More general guidelines for expressing learning goals are summarized in the ABCD guidelines (see above). Another research track identified lists of specific verbs that can be used to formulate behavioral objectives according to their type (see e.g. Kizlik 2002).

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<sup>17</sup> We will encounter again this issue when introducing the idea of *learning enterprise*.

### *Teachers should not Waste Time Writing Behavioral Objectives*

One of the basic idea underlying behavioral objectives is that if they are correctly defined instructors may develop just and adequate test items almost automatically from their type and characteristics. Against this, Merrill (1977) wrote an incredibly vehement paper claiming that behavioral objectives are a loss of time. As usual for this author, this is demonstrated analyzing real examples. Merrill's process is simple: he takes some tests developed with behavioral objectives and works backward asking: what objectives are being tested with these items? His conclusions are the following:

1. Behavioral objectives describe tiny abilities, which are necessary, but fail to express real and relevant internal learning events, such as *understanding*, which are the ones actually interesting for any instruction.
2. Types of test items (multiple choice, true/false, essays) do not match with types of objectives, but can be used in different ways for testing different types of objectives. True/false items can e.g. be used for testing understanding if used in an adequate way.
3. Test items should therefore be created according to criteria of:
  - a. Objectivity: if they test what they should. If the goal is the understanding of a concept, is a correct statement of its definition sound evidence?
  - b. Convenience: with 200 students, multiple choices tests may be better than essays.

The idea that types of test items can be eclectically used for testing different types of goals and objectives provides an interesting insight on the three-layer structure proposed in the opening of this Chapter. Goals and strategies belong in fact to the level of design, while types of test items are typical procedures, or techniques, and as such should be interpreted and somehow re-invented by designers in order to fit their situation (Cantoni, Di Blas 2002).

Concerning behavioral objectives, another critical remark could be done, trying to distinguish the goal from the effects observed in order to confirm the achievement. "Learning what a sample population is" means both mastering the explicit definition of the concept, and being able to apply it analytically (recognize a significant sample) and creatively (define a significant sample) – and it also means a lot more, such as being able to evaluate a statistical report on the basis of the sample selection. On the one side, expressing goals in terms of behavioral objectives partially solves the issue of the evaluation of instruction, but on the other may lead to an oversimplification, and also to a sense of frustration: Can we teach what cannot be expressed as observable behavior? With attitudes, this is particularly evident.

Another non-behavioral, yet quasi-behavioral, approach to goals and objectives is proposed in (Gronlund 1985) and (Gronlund 1995). The idea is that a simple way of expressing objectives is stating the general principle plus a sample of outcomes that the instructor would consider as a proof of achievement. One instance would be "Understanding what eye-contact is" with examples "when holding a presentation, keeps eye-contact with the audience; when asked to indicate the main success factor of face-to-face public speech recalls eye-contact". This approach keeps the positive qualities of behavioral objectives – their preciseness and easy relation to design and evaluation – at the same time offering more flexibility and adequacy to complex situations.

The line identified by Merrill and Gronlund is the one that will be followed in the following steps of this work. Merrill further contributed to the discussion with another work, namely the Component Display Theory (CDT), presented below. But before that, a look at some other models for expressing learning goals is necessary.

### **Bloom's Taxonomy of Learning Goals**

Benjamin Bloom (Bloom 1956; Bloom, Krathwohl & Masia 1964) proposed a first and widely known definition of different types of learning outcomes. Bloom's team worked inductively, collecting schools and colleges syllabi and constructing a general framework for describing them. The idea was to help the US education system to improve the quality of instruction with a tool that could support the discussion about "what we want to achieve".

They distinguished two domains of learning, described in two handbooks published in 1956 and 1964:

1. *Cognitive domain*: intellectual knowledge and cognitive skills such as Mathematics or Sociology learning.
2. *Affective domain*: values, interests, attitudes, opinions, appreciations, values, emotional sets and what is called today emotional intelligence, such as being attentive.

Bloom's handbooks analyzed the domains proposing different levels of knowledge that could be reached within each of them. The taxonomy is hierarchical (levels increase in difficulty/sophistication) and cumulative (each level builds on and subsumes the ones below).

Bloom's research group did not develop in-depth categories for another domain they identified, the psychomotor domain, claiming lack of experience in teaching these skills. Several authors proposed a completion, such as (Harrow 1972).

### *The Cognitive Domain*

Bloom (Bloom 1956) divides the cognitive domain into six levels that do not form a continuum. The first one (called *knowledge* in the *Handbook*, but often quoted as *recall*) includes types of knowledge, while other levels include (cognitive) abilities. Notice that the final step of cognition presented, *evaluate*, has actually a strong relationship with the affective domain. The authors indeed declare the tight connection between the two domains, but without providing a complete integration.

The detail of all levels is provided in the following list. Except for some short remarks in brackets and for the introduction to the main terms no comments were added. The original text is in this case the best reference for further explanations.

1. *Knowledge (Recall)*: dealing with specific single (instance) elements, both factual and conceptual.
  - 1.1. Specifics.
    - 1.1.1. Terminology.
    - 1.1.2. Facts (factual knowledge).
  - 1.2. Ways and means of dealing with specifics.
    - 1.2.1. Conventions.
    - 1.2.2. Trends and sequences.
    - 1.2.3. Classifications and categories.
    - 1.2.4. Criteria.
    - 1.2.5. Methodology.
  - 1.3. Universals and abstractions in a field.
    - 1.3.1. Principles and generalizations.
    - 1.3.2. Theories and structures (schemas and patterns).
2. *Comprehension*: grasping or understanding the meaning of information and relating it to one's experience. From this point on cognitive abilities are described.
  - 2.1. Translation.
  - 2.2. Interpretation.
  - 2.3. Extrapolation.
3. *Application*: the use of previous (abstract) knowledge in new and concrete situations to solve problems.
4. *Analysis*: breaking down informational materials or communications into their component parts, examining and understanding the organizational structure to develop divergent conclusions by identifying motives or causes, making inferences, and/or finding evidence to support generalizations.
  - 4.1. Analysis of elements.
  - 4.2. Analysis of relationships.
  - 4.3. Analysis of organizational principles.
5. *Synthesis*: understanding the relationship among the parts and the functioning as a whole, thus getting the "big picture" of what is being learned. This also means creatively applying prior knowledge and skills to produce a new (original) whole.
  - 5.1. Production of a unique object.
  - 5.2. Production of a plan or set of operations.
  - 5.3. Derivation of a set of abstract relations (a meta-plan, or a general plan).

6. *Evaluation*: assessing the value (or the truthfulness) of knowledge based on experience.
  - 6.1. Internal evidence (subjective evaluation).
  - 6.2. External criteria (objective evaluation).

### *The Affective Domain*

The second Handbook (Bloom, Krathwohl & Masia 1964) starts stating that objectives in the affective domain represent a huge portion of school and college educational objectives, although several issues make them trickier in the teaching practice. First of all, affective objectives have a slower attainment than cognitive ones, and are therefore more difficult to observe. Moreover, a just evaluation is not obvious.

The affective domain is structured on five levels. Like the cognitive domain, levels are sequential, but they represent a continuum in a process of *internalization* of values and practices, or in the assimilation of a culture.

1. *Receiving (attending)*: being able to attend to particular phenomena or stimuli being focused and attentive.
  - 1.1. Awareness (that a thing exists).
  - 1.2. Willingness to receive (see Lonergan's *inquiry*).
  - 1.3. Controlled or selected attention.
2. *Responding*: actively reacting and participating.
  - 2.1. Acquiescence in responding (obedience, compliance).
  - 2.2. Willingness to respond.
  - 2.3. Satisfaction in responding (such as being satisfied with one's response).
3. *Valuing*: attaching a value to a particular object, phenomenon, or behavior. This may range from acceptance to commitment, varying for attitudes and appreciation.
  - 3.1. Acceptance for a value.
  - 3.2. Preference for a value.
  - 3.3. Commitment.
4. *Organization*: bringing together different values, resolving conflicts among them, and starting to build an internally consistent value system, comparing, relating and synthesizing values and developing a "philosophy of life".
  - 4.1. Conceptualization (reflective assumption of a value).
  - 4.2. Organization (the value is included into a consistent horizon).
5. *Characterization (or internalization) of Value*: holding a value system and acting consistently, developing a "way of life". The resulting behavior is pervasive, consistent and predictable. Objectives on this level are extremely high-level and concerned with personal, social, and emotional adjustment.
  - 5.1. Generalized set.
  - 5.2. Characterization (construction of a personal *Weltanschauung*).

The analysis and statement of affective objectives are more difficult than of cognitive ones, although several authors indicate that a great deal of school-level objectives in K-12 and High School curricula belong to this domain. An interesting discussion of affective objectives is presented by (Lee & Merrill 1972<sup>18</sup>).

Bloom's taxonomy is important as it started the discussion about the expression of learning objectives with a structured contribution that has served as main reference point for several authors, and that is still under discussion today, as reported some pages below.

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<sup>18</sup> Interestingly, in this book Merrill uses the behavioral paradigm, which he will refuse only five year later in Merrill 1977. Merrill's work on learning objectives provides a favorite perspective on the evolution of the most epistemic aspects in Instructional Design.

## Gagné's Taxonomy of Learning Outcomes

Another important classification schema for learning objectives was proposed by Gagné. His taxonomy (Gagné, Briggs & Wager 1992) is articulated in five categories (also called *domains*) of knowledge.

1. *Verbal information*, or know that, which comprises the following types:
  - a. Labels: learning names, eventually without making sense of the concept or thing behind them (this matches with Bloom's *knowledge of specific terminology*).
  - b. Facts: declarative knowledge as it is usually understood, expressed as propositions stating a relationship between entities, such as "This laptop weighs 4.5 Kg". Examples of objectives on this level are "recall the names of the Italian presidents in the last 50 years" or "name the phases of hypermedia design" (this matches with Bloom's *knowledge of specific facts*).
  - c. Organized knowledge: structures of facts describing systems or complex situations, such as a description of the components of the aforementioned laptop.
2. *Intellectual skills* comprise a set of mental abilities concerning concepts, including:
  - a. Discriminations: distinguishing things according to features or categories.
  - b. Concrete concepts: categories created according to the physical characteristics of objects, or induced concepts.
  - c. Defined concepts and rules: abstract concepts such as *democracy* or *acid*, which are usually learnt by definition, along with the rules for using them properly, such as "democracy is a concept that can be specialized into different types of democracy, provided that some basic features remain unchanged".
  - d. High-order rules: rules that can be applied to rules.
  - e. Problem solving: more complex skills combining different concepts and rules.
3. *Cognitive strategies* describe a meta-cognition level – learning to learn – to approach new situations or topics. Cognitive strategies are domain specific, and may include abilities such as finding a trend from a large amount of data. Once learned, cognitive strategies become possible problem-solving strategies. Gagné provides sub-types:
  - a. Rehearsal: strategies for remembering and memorizing such as repetition, fitting into a schema, etc.
  - b. Elaboration: strategies for processing information or connecting it with other elements, etc.
  - c. Organizing: strategies for structuring large amounts of information into unified wholes.
  - d. Comprehension: strategies for achieving an understanding of experience.
  - e. Monitoring: strategies for controlling one's own learning process.
  - f. Affective: strategies for controlling attitudes and emotions in learning.
4. *Attitudes* are defined by Gagné as mental states that predispose a learner to choose to behave in a certain way, and are described as having affective, intellectual and behavioral components that interact. "An attitude influences a choice of a personal action on the part of the individual. (...) It is an internal state that affects an individual's choice of personal action toward some object, person or event." (Gagné 1992, p.86). The complexity of attitudes, which will be discussed again in Chapter II, makes the use of sophisticated strategies necessary, such as *human modeling* (learners acquire an attitude mostly by observing someone who acts in that way – namely, the teacher, an expert or an alumni).
5. *Motor skills* finally describe physical actions, movements and things we do with our body.

In (Gagné & Merrill 1990), the author also developed the idea of *learning enterprise* (which was indeed also latently present in Gagné 1985): the combination different types of knowledge into a more general expertise. The authors claim the necessity of expressing complex goals that reflect practice in the real world in order to enhance transfer. Learning enterprises are defined within the context of a scenario, and are achieved through the provision of a general schema integrating the different knowledge types into one whole and specifying the connections between them. The idea of complex goals has consequences on the practice of design:

*Whereas current instructional design methodology focuses on components such as generalities and examples, which are geared for promoting acquisition of single objectives such as concepts or procedures, a consideration of enterprises as integrated wholes may lead to a future focus on more holistic student interaction for 'transactions'.*

(Gagné & Merrill 1990, p. 29)

The idea of complex high-level goals is also elaborated by Gronlund in (1985; 1995), and highlights the track chosen in this work and finalized with the definition of the QUAIL model, presented in Chapter II.

After discussing the different types of learning goals Gagné analyzes how each of them can be achieved by instruction, influencing the internal process of learning through external stimuli. The idea is that the learning process follows determined steps (the Nine Events – see above), and should take different decisions according to the type of goal addressed.

Gagné also provides indications about how to express a goal correctly, following the behavioral track, and identifies a five-elements statement template:

- Situation: the setting in which the ability should be demonstrated (“while dictating a letter”).
- Learned capability verb: what should be done in term of performance verb (“demonstrates”).
- Object: what is actually being learnt (“fluent typing”).
- Action verb: the action by performing which the ability is demonstrated (“transcribing a letter”).
- Tools, constraints, special conditions (“in presence of a superior”).

This would result for example in "demonstrates fluent typing by transcribing a letter from oral speech while a superior dictates it".

### **The Performance-Content Matrix**

Merrill proposed a two-dimensional classification of learning outcomes in the context of his Component Display Theory (CDT – see e.g. Merrill 1983 and Merrill 1994). The CDT is “a set of prescriptive relationships that can be used to guide the design and development of learning activities”, which includes “a two-dimensional classification system with performance level as one dimension and content type as the other dimension” (Merrill 1983, p. 283). Merrill continues:

*The theory postulates that for each type of objective there is a unique combination of primary and secondary presentation forms that will most effectively promote acquisition of that objective.*

(Merrill 1983, p. 283)

The naïve claim provides even more evidence for the complexity of the instructional design activity, where the individual character of learners and instructors come in touch in a network of intentional interactions. Nevertheless, Merrill’s contribution to the definition of learning objectives is paramount, as it initiated the track of classification grids. Moreover it introduced a second concern with respect to Bloom’s and Gagné’s taxonomies: not only the type of knowledge, but also the level or scope to which it should be achieved.

Merrill identified four types of learning outcomes (content), namely:

1. *Facts*: declarative knowledge.
2. *Concepts*: the definition of categories and mental tools for the simplification and understanding of experience.
3. *Procedures*: sequences of rules and actions for accomplishing a task in a given situation.
4. *Principles*: general rules that can guide heuristic action.

Once again, the types are partially overlapping with the previous two taxonomies. Interestingly, Merrill proposed a new pattern for the levels of achievement, proposing three levels of performance:

1. *Remember*: recalling a fact, concept, procedure or principle (know that “the Capital city of Ticino is Bellinzona” but also that “for cooking pasta, first let water boil”). Merrill distinguished *remember-instance* and *remember-general*.
2. *Use*: applying some abstraction to a specific case, such as using a concept, applying a procedure or a principle (“if today is public transportation strike, do not look for a bus”; not just knowing what does it mean to drive safely, but actually drive that way).
3. *Find*: being able to derive or invent new concepts, modify or create a new procedure for a new set or subset of problems, or define a new principle (given the principles of Instructional Design, adapt them to a specific learning and institutional context; or extend a classification in order to include new elements).

The grid can be sketched in Figure 1.15, adapted from (Merrill 1994).

	FACTS	CONCEPTS	PROCEDURES	PRINCIPLES
FIND				
USE				
REMEMBER GENERAL				
REMEMBER INSTANCE				

Figure 1.15 - Merrill's grid for learning objectives

The Figure shows also off-limits areas on the grid: facts can actually be only remembered as instances, while no instances can be recalled for concepts, procedures and principles. The two latter cannot as well be represented on the level of remember-general.

Within the CDT theory, the performance-content grid is linked to the specification of test items and to a discussion of the very idea of subject matter.

Merrill's grid has the advantage of being simple (it defines only 4 types and 3 levels) and at the same time precise (4x3 means 12 possible distinct outcomes). The simple fact that it is a grid – a visual representation – increases its usability and intuitiveness. It will be reprised and merged with other contributions while introducing the QUAIL model.

### Bloom's Taxonomy Revised

Bloom's taxonomy continuous and widespread citation attests its perceived value over time and called two of the original *Handbook* co-authors to produce a revision, and to create a new tool for the classification of learning objectives (Anderson & Krathwohl 2001). The outcome is two-dimensional classification grid whose approach will be shared by E<sup>2</sup>ML.

### *Why Classifying Objectives?*

The emphasis in Anderson and Krathwohl's work is on classifying, rather than expressing, objectives. This is new, as it indicates a new direction with respect to the behavioral objectives discussion presented above. Classifying was indeed the proper goal also for Bloom's, Gagné's and Merrill's works, but a great part of the later interpreter focused on behavioral verbs and on a "correct wording" in expressing goals. Although making treasure of the expressive research of other authors, the *Taxonomy Revised* brings in a clear distinction, focusing on classification. The intent is providing a tool for thinking more clearly about objectives. The authors also stress the fact that the same term (e.g. recognizing) used for different objectives may actually refer to different cognitive processes. Secondly, the authors identify four questions that make worth classifying objectives, which could be read along with Yelon's (1991) presented above:

1. The learning question: "what is important for students to learn in light of the limited school and classroom time available?"
2. The instruction question: "How does one plan and deliver instruction that will result in high levels of learning for students?"
3. The assessment question: "How does one select or design assessment instruments and procedures that provide accurate information about how well students are learning?"
4. The alignment question: "How does one ensure that objectives, instruction and assessment are consistent with one another?"

These issues are given a possible solution as the classification of objectives supports six activities of instructors and designers, namely it helps educators:

1. To examine objectives from the student's point of view.
2. To consider the panorama of possibilities in education.
3. To see the integral relationship between knowledge and cognitive process inherent in objectives.
4. As "it makes life easier", as it provides some more or less standard types of objectives to which instructional strategies and assessment procedures can be matched.
5. As it makes more readily apparent the consistency, or lack of it, among the stated objectives for a unit, the way it was taught, and how learning was assessed.
6. To make sense of the wide variety of terms used in education.

After presenting the classification grid, Anderson and Krathwohl's book develops several *vignettes*, or case studies, showing how it can be used in real practice.

It is important to notice that the revised taxonomy addressed *educational objectives*, that is, course or unit objectives, while it is less suitable for *global objectives* (such as curriculum objectives) and *instructional objectives* (such as lecture objectives).

Moreover, the authors note that, and this is a valid general remark, objectives should be considered and defined within their specific grade and subject context, and that any classification tool undergoes slight re-interpretations or modifications according to that.

### *The Grid*

The grid proposed in the *Taxonomy Revised* incorporates new contributions from Psychology and Cognitive Science, trying to produce a synthetic view. It is developed on two axes: the former represents the *knowledge dimension*, i.e. the type of knowledge at stake; the latter represents the cognitive dimension, i.e. the cognitive process to be performed. The grid is reported in Figure 1.16. The following paragraphs provide a description of the values on the two axes (as usual, see the original book for further details).

THE KNOWLEDGE DIMENSION	THE COGNITIVE PROCESS DIMENSION					
	REMEMBER	UNDERSTAND	APPLY	ANALYZE	EVALUATE	CREATE
FACTUAL KNOWLEDGE						
CONCEPTUAL KNOWLEDGE						
PROCEDURAL KNOWLEDGE						
META-COGNITIVE KNOWLEDGE						

Figure 1.16 - Anderson & Krathwohl's grid

The types and subtypes on the knowledge dimension are the following:

1. Factual knowledge:
  - a. Knowledge of terminology.
  - b. Knowledge of specific details and elements.
2. Conceptual knowledge:
  - a. Knowledge of classifications and categories.
  - b. Knowledge of principles and generalizations.
  - c. Knowledge or theories, models and structures.
3. Procedural knowledge:
  - a. Knowledge of subject-specific skills and algorithms.
  - b. Knowledge of subject-specific techniques and methods.
  - c. Knowledge of criteria for determining when to use appropriate procedures.
4. Meta-cognitive knowledge:
  - a. Strategic knowledge.
  - b. Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge.
  - c. Self-knowledge.

The cognitive process dimension is articulated as follows:

1. Remember:
  - a. Recognizing.
  - b. Recalling.
2. Understand:
  - a. Interpreting.
  - b. Exemplifying.
  - c. Classifying.
  - d. Summarizing.
  - e. Inferring.
  - f. Comparing.
  - g. Explaining.
3. Apply:
  - a. Executing.
  - b. Implementing.
4. Analyze:
  - a. Differentiating.
  - b. Organizing.

- c. Attributing.
- 5. Evaluate:
  - a. Checking.
  - b. Critiquing.
- 6. Create:
  - a. Generating.
  - b. Planning.
  - c. Producing.

Although the categories are similar to the original taxonomy, their arrangement on a grid and the distinction of the knowledge and cognitive process dimensions make it a new and powerful tool. Anderson and Krathwohl propose to chart on their grid not only goals, but also activities (in relation to the specific goals addressed in them) and assessment (in relation to what is being actually assessed). Representing all the elements contributes to control the alignment or consistency of the whole instruction.

#### *Lessons Learnt from Macbeth*

One of the vignettes, or case studies, reported by Anderson and Krathwohl describes a unit of instruction about Shakespeare's *Macbeth* for senior college students. Two elements from this example are highly relevant for the further development of the work.

The main goal, as expressed by the instructor, is learning "to see the relevance of literary works such as *Macbeth* to their own lives". This is discussed and then translated by the authors as a comparison between the learner's experiences and the events, emotions and drives presented in the play – the result is remember/factual knowledge. Is this classification satisfactory? What is then the difference between comparing two plots and perceiving their relevance? Two elements are here probably missing:

1. The so-called affective domain: the perception of relevance implies the disposition of the learners to put their own experience in the discussion, and to get involved.
2. Perceiving relevance also requires a reflection on one's own experience and exigencies. The grid does not take into account the consideration of the subject as object of knowledge (except for meta-cognitive knowledge).

The first remark addresses a declared limit of the grid, which only describes cognitive goals. The point is that only few, if no, real goals can be satisfactorily described without considering the affective dimension. The second remark addresses a general limit of all the models reviewed here: self-reflective learning, which means learning about one's self, is a dynamic that should be expressed in order to identify the specificity of a number of learning experiences.

Another interesting remark, which reveals the great quality of the book, concerns a second goal for the *Macbeth* unit, which concerns the knowledge of some principal fact in the play (characters, plot, etc.). The authors note that no single activity directly addressed that goal, while students are expected to achieve it while pursuing other goals. This leads to a reflection about the linkage between goals and instructional strategies: not all goals should (or even can – think of attitudes) be achieved directly; rather, they can be achieved indirectly by involving students into activities that address other goals.

#### **IMS RDCEO**

Another interesting contribution to the discussion was recently proposed by IMS in the specification *Reusable Definition of Competency or Educational Objectives* or RDCEO (IMS 2003g).

The goal of this specification is to make the definition of learning objectives reusable, thus allowing the creation of shared catalogues of objectives. This would allow common reference for courses, so that an organization could declare that its instructional offer covers goals 145 to 237 of the US Ministry of Education Catalogue, thus providing a single public and detailed reference.

The RDCEO information model is actually very simple, and does not provide any insight in the nature of knowledge as the previously presented models do. RDCEO is simply a framework for allowing reference to common objectives catalogues. Each learning objective has therefore a unique identification (the couple catalogue/entry) and a human language title and description. An example of RDCEO objective can be seen in Figure 1.17, which also can provide the flavor of what an XML definition of an educational environment may look like:

```
<?xml version="1.0" encoding="utf-8" ?>
<rdceo xsi:schemaLocation="imsrdceo_rootv1p0.xsd
http://www.w3.org/XML/1998/namespace xml.xsd"
xmlns="http://www.imslobal.org/xsd/imsrdceo_rootv1p0"
xmlns:xsi="http://www.imslobal.org/2001/XMLSchema-instance">

<identifier>http://www.istituti.usilu.net/botturil/web/e2ml/xml/object
ives.xml#logic</identifier>

<title>
  <langstring xml:lang="en">Logic</langstring>
</title>

<description>
  <langstring xml:lang="en">Be able to define the term 'Logic' and
recognize a formal logic expression</langstring>
</description>

</rdceo>
```

Figure 1.17 - XML RDCEO statement

What is interesting is that an objective may optionally have a more formal definition, expressed according to some existing model, not defined within RDCEO, but proposed by other organizations as an allowed extension. This leaves the standard open to the integration with other taxonomies and grids.

## Summary

The definition of learning objectives is a primary topic in Instructional Design, and it is the place where the designer's understanding of education and teaching becomes deciding. But another consideration increases its relevance. Classifying learning goals means having a way of distinguishing instructional strategies, to map a way of conducting education (the holistic principle of an educational environment) to the expected outcomes.

The review pointed out that their definition could happen by crossing two main dimensions, the type of learning (facts, concepts, procedures, etc.) and the level of achievement (recall, application, etc.). The practice of behavioral objectives was also presented and discarded, introducing a different approach for their classification and expression.

These remarks introduce some short conclusions, that will wrap up the way done up to now and open further road.

## Concluding Remarks

Specific summaries have already been presented after each major section of the Chapter. The next few lines will nail down three pivotal points necessary for a correct understanding of E<sup>2</sup>ML in the next Chapter.

### About the Review

All models can be seen as a set of conceptual and practical tools for translating an instructor's approach into a definite design. Some of them then identify a precise path to procedures, such as Landamatics does. Generally speaking instructional design becomes lively thanks to the tension existing between the desire to understand teaching and learning (a matter of theories, and of approach) and the efforts to be practical (providing tools and procedures). It was also pointed out that that one moment when this tension evidently emerges is the definition of learning goals along with the definition of an instructional strategy. Here is probably the fascinating side of it, as of any technical science, which results in a methodological choice: investigate education, teaching and learning, knowledge and competencies, which are one of the greatest mysteries of human life, through reflecting over practice and finding ways for doing better.

Although this forcedly short review of Instructional Design cannot have any claim of exhaustiveness, I hope that the interdisciplinary approach chosen, which brought to meet XML just beside motivational issues, did not result into a weird feeling, but in a widening of perspectives. The very art of teaching lives from mixing and cross-fertilizing different disciplines.

### About Technologies

An important element of the review was the new contribution that the technology world brought (or is bringing) to instructional design, over the bridge of eLearning. Notice that for the greatest part of educators, *learning objects*, *XML* and *standards* still sound as quire tricky words.

Nevertheless, two facts should be considered:

1. A real diffusion and integration of technologies in education is possible only if these two worlds meet (this does not mean at all that instructors should become technology experts...).
2. The cultural crossover opens *per se* new perspectives for both worlds.

### About Instructional Design and Teaching

The idea one may have after this review is that Instructional Design is a scientific-like method for producing environments where learning *happens*, with all the necessary acronyms (!!), graphs, metrics, etc.

Actually, none can guarantee or produce learning – we all always learn, something every day, yet nobody can determine *what* we learn. A perfectly designed lecture may leave the students the impression that “the class was good, but where is the point in this stuff?”

For this reason, Instructional Design shares with teaching its nature of art. Like the *vibrato* for singing, techniques are part of the art – and so are models for Instructional Design. But the nature of art is revealed into the ability of the designer and of the educator: the response to the unpredictability of the real situation. Put all tools and models apart, creativity is a necessary aptitude for the designer. Any model or tool should be evaluated not only in terms of expressive power, but also in the freedom of thought and innovation that it leaves to its users<sup>19</sup>.

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<sup>19</sup> Interestingly, the most formal and apparently mechanical model presented, IMS Learning Design, declares its attention to innovation and differences. Actually the equation “more formal, less free” does not hold. It could be reformulated as the

For this very reason, the practice of professional instructional designer does not follow any of the models presented above. Models are rather understood as guidelines, and implemented in their general principles (ADDIE-like). Specific techniques are used for particular tasks that acquire relevance within a specific instance, but *heuristic* is the keyword, as the method directly depends on the nature of the instructional problem. Moreover, the designer's work is by nature collaborative, and seems to be structured in communities of practice, each of them creating its own way of doing it, its understanding of learning education and design: all of them use models, which are a product of research, in order to reflect on their practice, learning from it, and improve (Schwier, Campbell & Kenny 2003).

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following couple of statements: “the more formal, the more competence required” and “the more formal, the more powerful”.

## CHAPTER II

# E<sup>2</sup>ML - EDUCATIONAL ENVIRONMENT MODELING LANGUAGE

*"Force that is not converted into movement does not simply disappear, but is dissipated into damage done to joints, muscles, and other sections of the body."*

*(Feldenkrais 1972, p.58)*

## Introduction

The original contribution of this work to Instructional Design is E<sup>2</sup>ML – Educational Environment Modeling Language, a semi-formal visual language for the design of educational environments. Its development heads the call by Gustafson and Branch:

*As our final challenge, we remind instructional developers that, in this rapidly changing world, new ID tools, both mental and physical, are urgently needed. Merrill has repeatedly called upon all instructional developers to be toolmakers, not just tool users (...). We wholeheartedly concur in this position and believe more powerful tools are needed to aid in designing instruction whether or not they 'fit' existing ID models.*

(Gustafson & Branch 1997, p. 87)

The design issues presented in the Introduction addressed two broad topics: interdisciplinary communication and the structure of the design process. Dick, Carey and Carey point out that:

*When the designer is neither the developer nor the instructor (...) a premium is placed on precision specifications and working in a team environment requiring communication and collaboration skills.*

(Dick, Carey & Carey 1996, p. 250)

And they add that, for example:

*There is not such a thing as a standard operating procedure for the communication that occurs between a designer and material developers.*

(Dick, Carey & Carey 1996, p. 250)

This is exactly the main issue for E<sup>2</sup>ML, and it corresponds to what Greer called the development of a *blueprint*: a representation of the instruction that all stakeholders, designers, developers and instructors can understand and eventually agree upon (Greer 1992).

Although it is a representation language, and not an Instructional Design model in its classic sense (i.e. a modeling of the design and development process), E<sup>2</sup>ML fits into the broad definition by Gustafson and Branch:

*The role of models in ID is to provide conceptual and communication tools that can be used to visualize, direct and manage processes for generating (episodes of guided) learning. (...) ID models play a communication role by allowing people to visualize the associated process.*

(Gustafson & Branch 1997, p. 77)

This Chapter is devoted to the complete presentation of E<sup>2</sup>ML. The next Chapter will briefly discuss its sources, goals and use contexts. Chapter IV will present some case studies in order to proof its expressive power and to show how it can be integrated in the design process.

## Goals

The specific goals for which E<sup>2</sup>ML was developed were presented in the Introduction. They addressed visual support for design, the production of design documentation, and the process of reverse engineering and evaluation of instruction. After the analysis of Chapter I, they are reprised in the following paragraphs along with some comments in order to set the correct reference framework for the introduction of E<sup>2</sup>ML<sup>1</sup>.

1. Visualization for design:
  - a. The subject of instructional design is an interdisciplinary team. All system-oriented design models consider the interaction of technicians, subject matter experts (SMEs) and instructional designers. Moreover, the role of stakeholder as the person sponsoring the instruction should be included. Finally, the production of support materials or the provision of the infrastructure may be given to partners external to the organization. E<sup>2</sup>ML is a visual representation language developed for the instructional designer, which can *ease and enhance communication* in the design team and with external partners.
  - b. The requirement analysis for the tools and content materials to be used in a specific educational environment is a delicate issue, as it often requires great investments, both in the case of off-the-shelf solutions and in that of custom development. Product-oriented models address the issue of development, but leave the definition of requirements to the overall design process; on the other hand, instructional design models do not provide specific (formal) tools for requirement definition. E<sup>2</sup>ML is a tool for systematically defining and expressing the educational requirements of learning support materials, in the case of both selection and development.
  - c. Setting up an educational environment requires great economic effort (developing content, digitizing, buying and customizing applications, training staff, etc.), which should be balanced by an adequate return on investment. All Instructional Design models propose a phase of evaluation and revision as the key element that makes models iterative. The point is that the evaluation can take place only after the instruction; the only way for anticipating some result is a tryout and revision sub-process, effective but indeed costly. E<sup>2</sup>ML can support static quality assessment at design time through the expression of formal features, such as consistency. This can help distinguishing quality-critical applications or content from optional nice-to-have features, thus optimizing investments.
  - d. E<sup>2</sup>ML representation could be the basis for a project management approach to course development. The definition of the activities and components of an educational environment may actually be used for supporting the process and checking its implementation status.
2. Design documentation:
  - a. Representing an educational activity with E<sup>2</sup>ML means producing a documentation that can be archived, thus creating a historical record of the design community. The original attention of Instructional Design to evaluation, revision and improvement can be therefore supported.
  - b. Documented projects, or parts of them, could be eventually reused for new projects, thus capitalizing on past experiences.
  - c. The E<sup>2</sup>ML design of courses can be used for training novice designers and enhance the transfer of expertise from more experienced designers. Instructional Design models can be accompanied by case studies visually showing the structure of the instruction, and not only by course materials.
3. Reverse engineering and evaluation:
  - a. Given the complexity of educational environments and the uniqueness of each class and of each learner, unexpected learning outcomes may arise. They should be recognized in

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<sup>1</sup> Some may notice that these issues were not directly taken from the literature. They have been actually identified mainly through discussion with experienced instructional designers. A special thank for that goes to Larry Friedlander, Director of the Learning Lab at Stanford University (San Francisco) and Tony Bates, Director of the Distance Education and Technology Department at UBC (Vancouver). They were both invited in Lugano in the framework of NewMinE Doctoral School seminars.

the evaluation phase and eventually fixed with revisions. Instructional Design models propose methods for analyzing the evaluation phase results, such as the ones proposed by (Dick, Carey & Carey 1996). The point is: once that I have evaluated the instruction, and found a problem, where should I act for fixing? Are there alternative solutions? Which one is the most effective, which the most efficient? Educational environment modeling with E<sup>2</sup>ML may be a diagnostic tool for identifying relevant issues and for figuring out viable redesign solutions.

- b. Documentation of past designs can be used for evaluating a course *ex-post* (together with learners' feedback and other elements). This process would also allow, once that several projects were gathered, the comparison among them, and the eventual definition of pedagogical patterns. A specific section of Chapter IV will provide examples.
- c. Documenting a course makes it more accountable.

## Versions

The general approach and strategy of E<sup>2</sup>ML is *visualization*: the main idea – which is actually a truism – is that being able to *see* the object being designed may improve the design itself by enabling communication and stimulating reflection<sup>2</sup>.

E<sup>2</sup>ML comes in two versions, presented sequentially in the following pages:

1. The *core version* is less formal and more focused on visuals. It is a lightweight tool with low costs for its deployment in the design process.
2. The *advanced version* is more formal, requires more information and more time investment for producing the documentation. As a counterpart, it provides more straight guidance and a finer interface to technology standards.

## Document Sets

Integrating E<sup>2</sup>ML into the design process means modeling the instruction into a set of documents, which serve as reference for the design and development team, and provide a support before, during and after the instruction.

Both versions share a common structure of four document sets:

1. *Goal Definition* documents: the formal statement of the educational goals. It is composed by two documents:
  - a. Goal statement.
  - b. Goal mapping.
2. *Action Diagrams*: the description of the learning and support activities designed for the instruction.
3. *Resource Lists*: the listing of the resources (tools, places, people) that may be exploited in the learning environment. Lists are the following:
  - a. Role & actor list.
  - b. Location list.
  - c. Tool list.
4. *Overview Diagrams*: three different overviews of the whole design, each presenting different features:
  - a. Course breakdown statement (CBS, only for the Advanced Version).
  - b. Dependencies diagram.
  - c. Activity flow.

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<sup>2</sup> This is indeed a general remark that can be applied to all situations characterized by complex information.

The Core Version does not provide any guideline for the resource lists, and does not include the CBS. The Advanced Version offers a formal definition of the three resource lists and of the CBS, and adds two features to the action diagrams.

These documents are described in the following sections in their standard form. Each document will be presented through a general definition, the allowed syntax, some examples and a statement of its possible use within the design process.

As any real design process and any real instructional situation have its own unique features, they can (actually should) be adapted, simplified or detailed, to the needs of the specific context or design team. The case studies in Chapter IV will provide examples of such adaptation. For instance, the general documentation may be arranged creating specific views (through filters on the whole documentation) for the needs of a particular role in the design team, thus creating a software developer- or instructor-specific documentation.

According to the main scope of this work, the presentation of E<sup>2</sup>ML is targeted to Instructional Designers, and is focused on how the design process looks like when introducing E<sup>2</sup>ML. It is therefore not technical, and may look inconsistent or incomplete to people with a more technical background. A more formal description of E<sup>2</sup>ML is hinted at in Chapter III.

## E<sup>2</sup>ML Core Version

### Goal Definition

All Instructional Design models insist on the importance of a clear statement of learning goals the expected outcomes of the learning process. From a practical point of view, expressing goals is important for different reasons:

1. Formulating a goal statement obliges the instructor or subject expert to reflect about the real objectives and not only focusing on content.
2. Goals provide a shared reference to the development team.
3. Goals provide indication for a consistent selection of content, and for the development of the instructional activities and of the assessment (Anderson & Krathwhol 2001).

Several models provide tools for instructional analysis, the breakdown of goals into smaller units, thus defining sub-goals, specific objectives and entry competencies. E<sup>2</sup>ML provides a complementary tool for the classification of high-level goals, similar to Merrill's Content-Performance matrix and to Anderson & Krathwohl revised taxonomy grid, both presented in Chapter I.

#### *Goal Statement*

The goal statement is a table collecting high-level goals and eventually major sub-goals. Goals are described by the elements represented in Table 2.1 (here and in the following definitions, elements in square brackets are optional):

GOALS		
ELEMENT	DESCRIPTION	EXAMPLE
TAG	A unique identifier (used for reference)	G1
STATEMENT	A text statement of the goal, expressed from the point of view of the learner. Goals can be detailed by sub-goals, expressed in the same form	Learning to read and understand a special purpose text in economic English in a proficient way for daily work.  SUBGOAL - Learn specific vocabulary
TARGET	The learners who should achieve the goal	The whole class OR Students who also take the ENG3 course
STAKEHOLDER	Who expressed the goal and has interest in its achievement	The Faculty Dean OR The Instructor
APPROACH	How the goal is approached; general indication of method or instructional strategy	Case study OR Examples and discussion
ASSESSMENT	When (and how) the achievement of goals is tested. [Indicators of achievement]	Exercise on a text during the written exam OR Writing a summary of an article from the "Business Week" – Achieved if language is correct, no spelling errors and gets all important points
[IMPORTANCE]	The relative importance value of the goal in the context of the whole course	5

Table 2.1 - Goal statement definition table

The criteria used for the definition of elements deserve some remarks.

First of all, there is no tight connection between goals and test items. The assessment column simply reports the moment in which it will take place (it is actually the name of a specific *action*, see later), as a test or in any other form. This allows a more synthetic definition, and at the same time grants the designer more freedom and flexibility. The point is that goals should be clear enough *to the designer* for creating test items. Eventually, indicators of achievement could be annotated (Posner & Rudnitsky 1997).

This clearly distinguishes this approach from the strict behavioral one discussed in Chapter I<sup>3</sup>. E<sup>2</sup>ML allows the designers to use a verbal expression they feel comfortable and familiar with, and which they can understand and control. This means that any type of formulation can be used: from behavioral guidelines, to Gronlund's guidelines (1985; 1995), or a loose statement. In this sense E<sup>2</sup>ML is eclectic, and does not force any particular view of education or learning.

Another new element is the *stakeholder*. Its importance was already previously discussed.

Finally, assigning goals a relevance score can help ranking them, thus defining priorities. This is of course bound to the stakeholder (some stakeholder may be more "weighty" than others). The importance score can be calculated as a generic value (referring for example to the Instructor's perception, or to students feedback) or as (balanced) average of the individual importance assigned by the different stakeholders<sup>4</sup>. Indicating target, stakeholders and relevance (eventually ranking goals) is important to estimate investments and, after the enactment, for a more sensible assessment of results.

<sup>3</sup> All the same, the "behavioral guidelines" (e.g. the ABCD model from ASSURE, or as expressed in Kizlik 2002) can be maintained, as they provide a support for not being too generic. The real difference is in the idea of *behavior* or better *performance*, which for E<sup>2</sup>ML does not necessary mean directly observable and testable, rather an occurrence in learning the results in a change of behavior which could also not being directly elicited within the instruction. It may be important, e.g. in a High-School Physics course, that the concept of *particle* is fully grasped by the students; we may test it by directly asking the definition; yet a real change in behavior can be difficultly observed. Nevertheless, this may impact on the students once they (or some of them) enter a University of Science.

<sup>4</sup> As a practical choice, I suggest using a list with the following values: 1 = if possible; 2 = nice to have; 3 = average; 4 = important; 5 = required. This scale will be used here and later in the case studies.

The example in Table 2.2 is taken by a 2 hours' class activity for 5<sup>th</sup> grade children about an introduction to the brain<sup>5</sup>.

GOAL STATEMENT						
TAG	STATEMENT	TARGET	STAKEHOLDER	APPROACH	ASSESSMENT	IMP.
G1	Know that we all have a brain and a nervous system as all animals (but not plants and things)	All students	Instructor	Activity	-	5
G2	Being able to describe a brain (macroscopic)	All students	Instructor	Watch drawings + 3D model	Drawing a brain	4
G3	Know that the brain is divided into functional areas that communicate with each other	All students	Instructor, students	Watch drawings + 3D model + story	Drawing areas of a brain and explaining that orally	3
G4	Know that the brain is composed by neurons. Be able to provide a simple definition of neuron	All students	Instructor, students	Story + drawings	Providing oral definition	3
G5	Act safely in order to avoid brain damages	All students	Headmaster	Discussion	-	4
G6	Develop interest into neuroscience, formulate questions	All students	Instructor	See the instructors + activities	Formulation of questions after the instruction	4

Table 2.2 - Goal statement example

Different stakeholders formulated the six goals in Table 2.2: the instructor, the school headmaster, and the children themselves, who were asked to jot down questions concerning this topic before the activity was designed. For two goals, no direct assessment is indicated: G5 is an attitude that in children cannot be expected to develop all of a sudden, while G1 is a general cognitive goal, for which indeed no direct testing is necessary.

### *Goal Mapping*

In order to enhance communication within the design team, learning goals can be expressed visually, by mapping them on a grid or representation. This can be used to represent the goals' relationship with the learning dynamic in its general structure and the type of knowledge or skill (Bloom's taxonomy, Gagné's types of learning outcomes, or Lonergan's learning dynamic model, etc.); or with the discipline itself, as a static knowledge structure (e.g. exploiting a concept map of the subject matter, or of the process to be mastered, etc.).

A number of epistemological considerations could be brought in at this point, which would require a whole book and are not within the scope of this work. The visualization of goals in E<sup>2</sup>ML is all about practicality: it can be useful as all team members may indicate where they are going to, and a possible way to that. From this perspective, two points deserve great care: first of all, the representation device should be consistent with the kind of goals addressed (cognitive, psychomotor, affective); secondly, the designer should be familiar with the representation and be conscious of – if not share – its underlying implications. For these reasons, E<sup>2</sup>ML does not provide a unique way of representing learning goals: designers can use any model they feel comfortable with, and believe fit to the subject matter and goals.

Nevertheless, a specific tool for goal classification was developed with E<sup>2</sup>ML: the QUAIL model.

<sup>5</sup> The development of this activity was achieved within the *ICeF Research Seminar 2002/2003* of the Istituto Comunicazione e Formazione of the Università della Svizzera italiana in collaboration with Settimana del Cervello Ticino.

*The QUAIL Model*

Three claims by Anderson & Krathwohl (2001) can probably provide the best introduction, as QUAIL could be seen as a refinement of their grid.

1. The focus is not on the expression of goals, rather on their definition and understanding by the designers.
2. Classifying goals may help in facing four issues in Instructional Design, namely: the learning issue (what should be learnt), the instruction issue (how to teach it), the assessment issue (how to assess the achievement of goals), and the alignment issue (how can all the components of an educational environment be consistent).
3. Objectives should be defined within a context, expressed by the curriculum, the grade, etc. The interpretation and use of a model for educational objectives may vary according to it.

Let's analyze some examples. The goals presented above in Table 2.2 are sketched below in Figure 2.1 on Merrill's matrix (1983).

	FACTS	CONCEPTS	PROCEDURES	PRINCIPLES
FIND				G6
USE				G5
REMEMBER	G1	G2 G4 G3		

Figure 2.1 - Example of goal visualization on Merrill's matrix

While G1 concerns a fact (we all have a brain), G2, G3 and G4 have to do with concepts (what the brain is like, functional areas, and the neuron). G5 concerns an attitude (to act safely), which could be translated (although this does not fit completely) into principles to use in certain situations. The representation of G6 (develop interest in neuroscience) is more controversial: the matrix does not have a specific space for interest – it was translated into principles (a way of behaving, in a certain way), which are open to transformation in the *find* level.

The same goals could be represented on the grid developed by Anderson & Krathwohl (2001) as a revision of Bloom's taxonomy. The result is shown in Figure 2.2.

THE KNOWLEDGE DIMENSION	THE COGNITIVE PROCESS DIMENSION					
	REMEMBER	UNDERSTAND	APPLY	ANALYZE	EVALUATE	CREATE
FACTUAL KNOWLEDGE	G1 G3 G4					
CONCEPTUAL KNOWLEDGE		G3 G4 G2				
PROCEDURAL KNOWLEDGE			G5			
META-COGNITIVE KNOWLEDGE						G6

Figure 2.2 - Example of goal visualization on Anderson & Krathwohl grid

This grid allows the localization of a goal in more than one cell – it happens for G3 and G4, which are split between facts to remember and concepts to understand. This reveals that those goals contain two components that share the same relationship existing between G1 (the fact that we have a brain) and G2 (what the brain is like). G5 was transformed into procedures (although principles grasped its essence better). The problem with G6 remains: interests have not a proper location on the grid.

In any case, a visualization or mapping is a profitable starting point for instructional analysis and for discussing the goals with the instructor and the subject matter expert. Moreover, after the instruction, a visual model can be exploited for identifying eventual learning gaps for unachieved objectives.

In order to let emerge the relevant issues, I have exploited a small trick. Goals should be analyzed and decomposed *before* mapping them on this kind of visualizations. The limits they present are partially due to this. Nevertheless, and this is the point, the instructor, the subject expert and the designer *think* in terms of high-level goals. They can afterward be analyzed and decomposed – but this is a technique, useful for the further design steps, yet unnatural. A teacher does not only think of behaviors, but also of ways of thinking, judging, perceived values, interests, etc. This is why I believe a tool for representing high-level goals *before* instructional analysis may be a powerful design support. The QUAIL model is not a tool for instructional analysis, but a visualization device for enhancing team communication about high-level goals. As such it can be surely used both before and after decomposing the goals: the representation of lower-level goals does not present any particular difficulty. Entry competencies could be also represented on the QUAIL model, thus allowing determining the gap in terms of level and scope, as explained below.

The QUAIL model is a possible representation device for high-level cognitive learning goals. *High-level goals* are goals that could not be expressed as performance objectives without further analysis and decomposition; they correspond to *educational goals* as defined in (Anderson & Krathwohl 2001). *Cognitive* means that psychomotor goals are not addressed here and could be hardly represented in this model; in this sense the QUAIL model is concerned with the cognitive *and* affective domains of Bloom's taxonomy (Bloom 1956; Bloom, Krathwohl & Masia 1964).

The QUAIL model is a three-dimensional grid representing the *type* of learning outcome, the *level* of knowledge and the *scope* of application<sup>6</sup>.

The use of three dimensions is justified by the literature review reported in Chapter I. Namely:

1. Bloom's taxonomy levels for the cognitive domain are not continuous, but are split between *knowledge* and *abilities*. These are here reported on two different axes. This is also the solution proposed by Anderson & Krathwohl (2001).

<sup>6</sup> The term *scope* metaphorically indicates here the virtual space or area of application of the goal, i.e. the way the goal should be reflected in the practice and behavior of the learner once it is achieved.

2. The definition of the *performance* for an objective, discussed with behavioral objectives, could not be left out. It is here present in the three scopes, which reprise Merrill’s Content-Performance matrix (1983).
3. The distinction of two cognitive and affective domains is analytically justified, but it is an unnecessary hurdle in expressing goals. Moreover, a large number of objectives require the simultaneous reference to both domains. As stated in the Introduction all knowledge requires a movement of cognition and affection. The knowledge levels proposed here, which are taken from Lonergan’s learning dynamic, are an attempt to establishing continuity between the two of them.
4. All models reviewed missed the distinction between external knowledge objects (such as “learning the solar system planets”) and self-reflective learning (“perceive the relevance of literary works to one’s experience”).

Another original feature of the QUAIL model is its name, which does not come from an acronym, but from the very bird<sup>7</sup>. The QUAIL model will be reprised in the Chapter III for assessing its compliance with the IMS RDCEO standard. The case studies in Chapter IV will offer example of its use in practice.

### Type

The types of learning goal are taken from Gagné’s classification (Gagné, Briggs & Wager 1992), adding interpersonal skills. The types considered are:

- Factual knowledge: declarative knowledge, know-that.
- Concepts: categories, types of objects, defined concepts, abstractions.
- Procedures: steps in a process for accomplishing a task or achieving a goal.
- Principles: guides to heuristic actions.
- Attitudes: dispositions to behave.
- Learning strategies: meta-cognitive strategies, learning to learn.
- Interpersonal skills: ways of relating to other persons, communication skills.

Complex goals can be represented grouping different types of goals into a sort of balloon.

The representation of self-reflective learning, i.e. learning experiences in which the learner’s self is both subject and object of knowledge (such as in “Expressing and evaluating one’s idea of education”) is another distinctive feature of QUAIL. Any object type can be used for self-reflecting knowledge, for discovering how one learns, how one behaves in defined circumstances, or how one performs an action. Self-reflective goals are represented with a self-looping arrow on them.

Goals types are represented in the visualization by shapes such as presented in Figure 2.3:

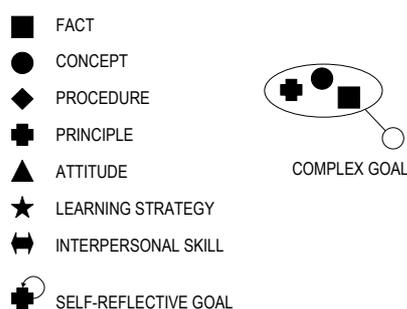


Figure 2.3 – The QUAIL model: types of learning goals

### Level

<sup>7</sup> “Doing the jump of the quail” in Italian means putting together two things that at a first sight seem completely different.

The levels of knowledge are described according to a novel model in Instructional Design, namely Lonergan’s representation of the learning dynamic (see e.g. Lonergan 1957), already presented in the Introduction. The learning dynamic is organized into three main levels – experience, understanding and judgment – each including three steps, as sketched in the Figure below:

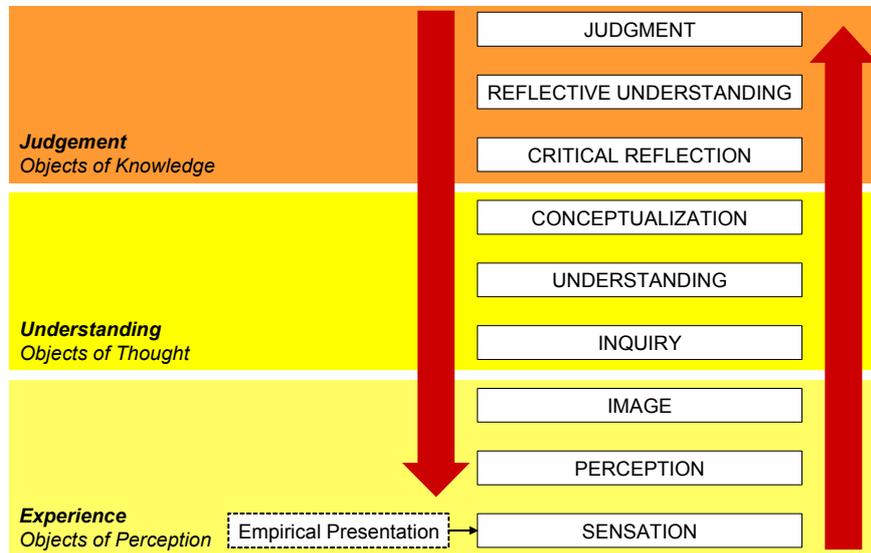


Figure 2.4 - Lonergan's learning dynamic (reprinted from the Introduction)

The level of experience concerns our senses impacting objects (sensation), filtering and organizing it according to expectations, values and beliefs (perception) and reconstructing the object in our minds (image), thus *seeing* the object, being able to consider it as a whole. The level of understanding concerns the mind, or *intellectus*, asking questions about the object (inquiry – “What is it?”, “How is it?” and “Why is it so?”), grasping the answers in the instance situation (understanding or insight), finally formulating – also verbally – the new knowledge as a concept, for example a reusable generalization or abstraction. The level of judgment concerns the learner asking “Is it true?” about the newly acquired knowledge (reflection), gathering evidence for the assessment (reflective understanding), from prior knowledge or from facts, finally expressing a statement of validity.

Notice that, although the focus is on intellectual knowledge, every level engages the person as a whole being: the energy that generates the shift from one level to another is the learner’s freedom and drive to know.

In order to integrate it in a tool for design, the level structure has been reworked on three points:

1. Sensation, perception and image are usually not addressed by the instruction, as they are not properly *cognitive* levels (they come before cognition, even if they are influenced by it). They have been therefore reduced to one single step labeled *experience*, which concerns the consideration of a specific object<sup>8</sup>.
2. The level of judgment was reduced to two levels:
  - a. Reflection, which is the same as Lonergan’s;
  - b. Commitment, which includes reflective understanding and judgment. These latter are in fact personal activities of the learners, strictly correlated, and which can seldom be separated in practice. An instructor can therefore hardly act on reflective understanding; nevertheless, the act of judgment is an important objective (the learner being sure of what

<sup>8</sup> Notice that the levels of sensation and perception should be considered if addressing psychomotor goals, as they profoundly impact on reflexes and unconscious action.

s/he has learnt). It was labeled *commitment* in order to stress that asserting the value of knowledge means recognizing its importance *for one's self*.

3. Finally a new level was introduced, named *action*. This level was not in *Insight*, the main Lonergan's text about human understanding (Lonergan 1957); the same author introduced it in a later work (Lonergan 1980), with the name of *responsibility*, i.e. the personal response to what the newly acquired knowledge requires from us. In the QUAIL model, this was necessary in order to represent attitudes and changes in the behavior.

The level of understanding was left untouched, as it includes the steps in which instruction may have the greatest freedom of action, working on concepts and language, and getting the insight of instance cases.

The final structure of QUAIL is sketched in Figure 2.5. The four groupings of levels indicate the great phases of *experience*, *understanding*, *commitment* and *action*.

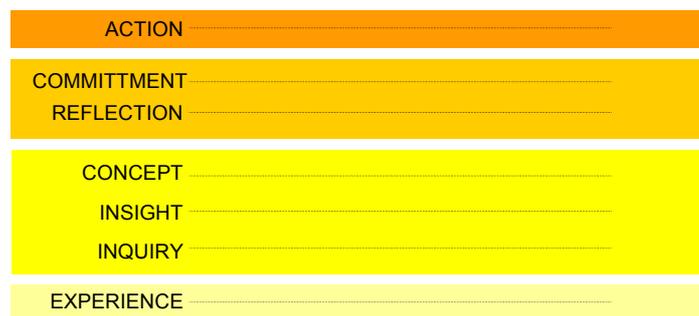


Figure 2.5 – The QUAIL model: levels of knowledge

The QUAIL model represents therefore levels in the learning dynamic that describe the status and integration of knowledge within the learner's horizon, or as developments of the learner as person (Cantoni & Di Blas 2002). The definitions of levels are the following:

1. Experience:
  - a. Experience: Meeting, considering a possible object of knowledge, and perceiving a correct image of it, which becomes part of the world of the learner's.
2. Understanding:
  - a. Inquiry: Rising interest and asking "What is it?" and "How is it?" concerning the potential object of knowledge.
  - b. Insight: Understanding a single instance case, grasping the essence (pattern of intelligibility) of the object of knowledge as a single case.
  - c. Concept: Through generalization, induction and abstraction, form a reusable and articulated formulation of what is understood. The generation of concepts requires a (verbal) language or means of expression.
3. Commitment:
  - a. Reflection: Parallel to inquiry, it means asking, "Is it so?" concerning the new knowledge. Although the word reflection was used for readability, it should be understood as *critical reflection*.
  - b. Commitment: Assessing the value of the newly acquired knowledge as relevant to the learner's self.
4. Action:
  - a. Action: Including the new knowledge in the action, as integrated part of the learner's self. This means that after intelligence, freedom (or free will) should be put in motion in order to act the way one has learnt, and to realize the *commitment*<sup>9</sup>.

<sup>9</sup> This also raises the issue of the ethical dimension of knowledge, and therefore of teaching and learning (e.g. as responsibility of knowing something).

Lonergan's definition of levels recalls Bloom's taxonomy. But while Bloom separated the cognitive and affective domains (although insisting, in his Handbook II, on the tight connection between the two of them), Lonergan offers a synthetic presentation of the learning dynamic, merging cognition and affection: both the affective internalization process and the cognitive hierarchic development could in fact be mapped on the seven levels.

### Scope

The last dimension of the QUAIL model considers the scope of knowledge, which describes to what extent the new knowledge is expected to influence the learner. With other words, the scope could be expressed as the terminal part of the instructor's sentence "I want the learners to know X in order to Y", where X defines a specific knowledge of a defined type and level, whereas Y defines the expected result in terms of change in the learners, i.e. the scope.

The metric is defined according to the performances in Merrill's matrix. The three possible scopes are (see Figure 2.6):

1. Remember: recall knowledge as such.
2. Use: apply knowledge to specific situations.
3. Find: exploit knowledge in order to generate new knowledge.

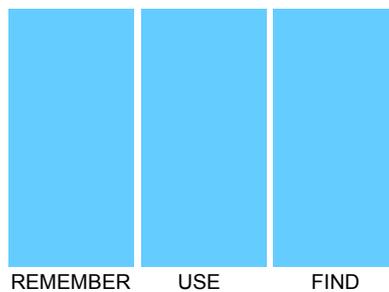


Figure 2.6 - The QUAIL model: scopes

### The complete model

The complete model, articulated in its three dimensions, is represented in Figure 2.7.

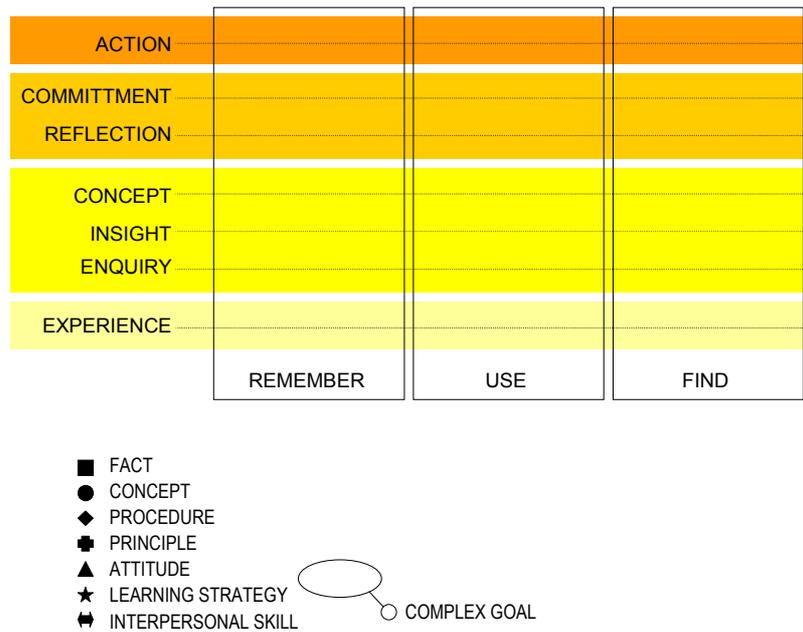


Figure 2.7 - The complete QUAIL model

Each goal is therefore represented on the model by assigning it the three values of type, level and scope. The goals from Table 2.2 could be represented as in Figure 2.8:

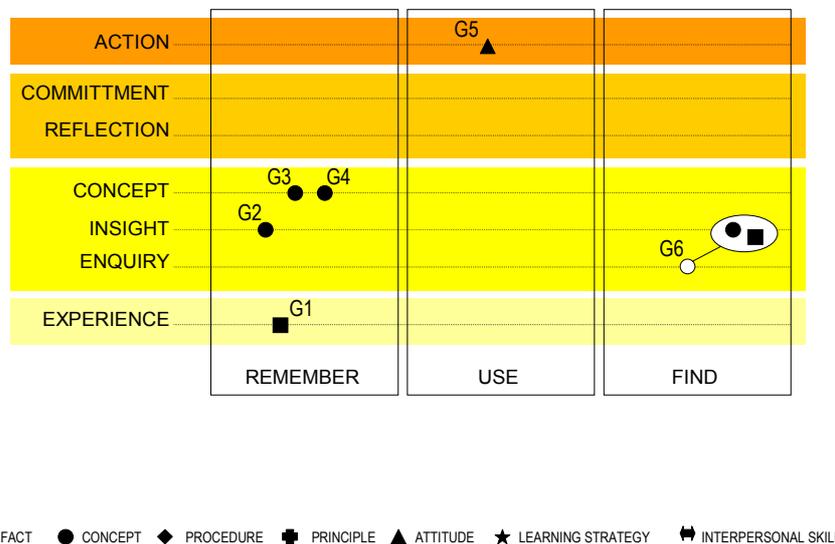


Figure 2.8 - Example of goals represented with the QUAIL model

First of all, notice that G6 gives here little trouble: the addressed level is that of inquiry about facts and concepts of neuroscience. Its scope is *find*, as it promotes learners to look for new knowledge in this domain. Secondly, a slight distinction between G2, G3 and G4 is made evident: the former indicates the capacity to describe what a single brain is like (which means, getting the insight of it thanks to the

concept of brain) while G3 and G4 concern definitions (of neuron and of functional area). Finally, G5 can be placed as an attitude on the level of action.

### Complexity and Expressive Power

The QUAIL model is quite complex and requires practice in order to become a familiar tool. Its complexity comes from the natural complexity of human knowledge, and from the desire not to oversimplify it. Some illustrative examples follow.

1. “I want my students to have seen, at least once in their lives, a formal definition of the mathematical term *function*. I will ask them neither to repeat it, nor to understand it – just to know it exists”. How could it be classified? The mathematical definition of *function* could be considered as a fact of which learners should be made aware, but this sounds strange, as it is a typical defined concept, according to Gagné. QUAIL would describe it as a concept on the *experience* level: learners should consider the existence of such a concept, though they are not required to understand it or acquire it fully.
2. “I want students to see what a classic Democracy is.” That of Democracy is indeed a concept, but how can you *show* it? An instructor can show an instance case, and from that gain an insight, then define a concept. Nevertheless, the goal concerns the concept as such. QUAIL would represent it as a concept type on the insight level: getting an idea of the concept of democracy, without reaching a complete formulation or definition. The scope would be *remember*.
3. *Procedure*, *attitude* and *learning strategy* are the types that describe the result of the involvement of freedom and will with knowledge. Actually, any procedure is indeed a set of known facts, of situation-grasping abilities, and heuristic principles. Yet, there is something more in learning to apply a procedure, and in applying it to real situation: the learner’s decision to use it. The same can be said for learning strategies and attitudes. This is why these three types can be represented in a valid manner on any level, and in any scope. It may sound weird that a procedure can stay within the remember scope, but think of the following example: “I want my employees to know how they should *not* behave in such situations”. This is a procedure goal on the level of commitment (a judgment should be formulated, that that procedure is *not* adequate to the case).
4. QUAIL’s approach to acquired attitudes is interesting as it reveals the particular expressing power of this model. Other models simply propose a kind of outcome called *attitude*, but there are a number of ways in which a learner can relate to an attitude, such as knowing that the attitude “be collaborative” exists (this would be on the *experience* level), being able to describe it (on the *concept* level), value it (on the *commitment* level, as “being collaborative is good” or “being collaborative is dangerous”) and finally actually *being collaborative*. Moving from the knowledge of an attitude to acquiring it is not an easy path, and is one that instruction can support – so being able to describe it is an important gain. In the same way the QUAIL model represents concepts, factual knowledge and other types of learning outcomes. Exactly as attitudes, one can know that a set of concepts exist (such as the quantum theory) on the *experience* level, without knowing it in detail. One can learn and solve a problem (such as a design problem – this is an *insight*) without being able to describe the procedure and principle s/he applied (on the *concept* level).

Finally, notice that the area defined by the *action* level and the *remember* scope in fact is empty: any objective on the *action* level will be represented within the *use* or *find* scopes.

### Prerequisites

The QUAIL model can be simply extended in order to represent prerequisite relationships between goals using oriented arrows. Figure 2.9 presents prerequisites in the example case (in order to acquire the concepts, the fact that we have a brain is required; in order to develop the attitude to act safely, the idea of functional areas is important).

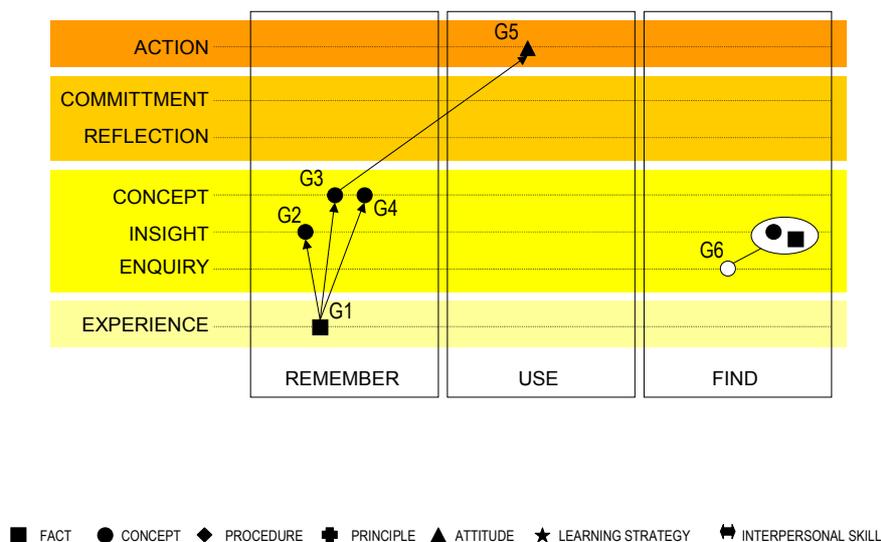


Figure 2.9 - Example of prerequisite relationships

This extension will not be developed further in this work, as the focus will be on E<sup>2</sup>ML, and QUAIL will be used as a part of it.

### Strategies as paths

QUAIL can also help in matching learning goals to instructional strategies. An instructional strategy consists in a method for letting learners achieve new knowledge starting from their current knowledge status. Graphically, the initial status of a learner could be represented as a set of knowledge statuses on the QUAIL grid. An instructional strategy would then be a path from statuses to goals.

This can be generalized. In order to have learners to get the concept of *information*, one can proceed in basically two ways: defining the concept (on the concept level) and the moving downward to understanding and experience; or recalling some experience of information, discussing it, having an instance understanding and then moving upward to a concept. Several strategies, with different knowledge types, level of knowledge and scope, could be described this way.

Like prerequisites, this description of learning strategies will not be exploited in the rest of this work.

## Action Diagrams

Action diagrams, collected in the second document set, are the core part of E<sup>2</sup>ML. Its framework is in fact centered on the representation of educational environments as structured (holistic) systems of educational activities. Activities (called *actions*) are performed by actors with specific roles, exploit locations and tools, and are aimed at the goals and sub-goals declared in the goal definition.

### Action Definition & Structure

The action is the minimal a unit of the educational environment. An action is the performance of a set of acts with a unity of purpose by defined acting subjects. Unity of purpose means that the action is aiming at one thing, such as producing a report, completing an exercise, achieving the understanding of a set of concepts, etc. The acting subjects can be a single learner along with the tutor, a whole class with the instructor, a tutor alone, etc. An action can be split in several sub-actions according to the time and/or space unity criterion in the specific setting (e.g. a single lecture, a videoconference). This second distinction (time/space) should match with the previous one (goal/subject). These considerations should be taken into account for selecting the granularity of E<sup>2</sup>ML representation,

which directly depends on the actions defined. In any case, granularity should be adequate to the specific project or design context.

The general schema for the representation of an action is presented in the left-hand side of Figure 2.10; the complete E<sup>2</sup>ML action diagram is actually more detailed, and is reported on the right-hand side of the same Figure.

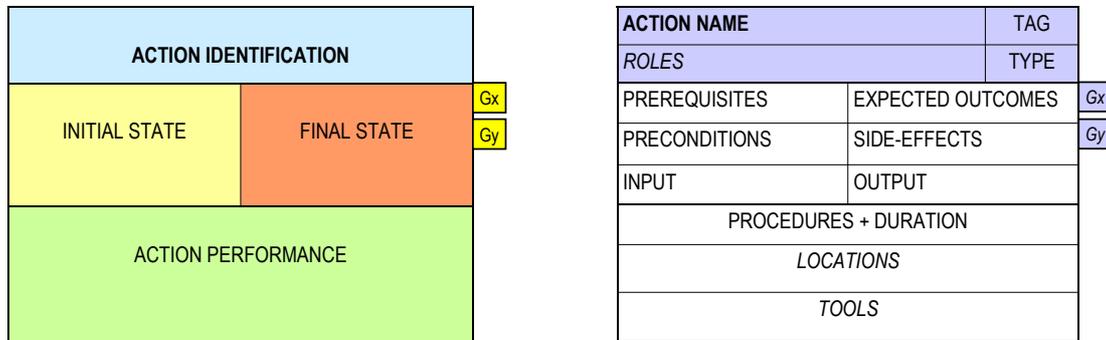


Figure 2.10 - Action diagram schema

The upper part of the diagram contains the proper identification for the action: its identifier tag, name, type and the involved roles (the acting subject). The middle-left area describes the initial state, i.e. the necessary and sufficient conditions for learning to be achieved, or for the performance to be successfully completed. The middle-right area describes the (desired) final state after the action performance. Finally, the lower part of the diagram contains a description of the effective action performance, including the involved locations and tools. The squares hanging on the right-hand side are references to the learning goals via the identifier tags defined in the goal statement. The definitions of the elements are provided in Table 2.3.

ACTIONS		
ELEMENT	DESCRIPTION	EXAMPLE
TAG	A unique identifier (used for reference)	PS4
NAME	The action name	Practice session 4
TYPE	The type of action (learning/support)	Learning
ROLES	The roles involved in the action, eventually the names of the people	Students (all), Tutor (Mark)
PREREQUISITES	Competencies or prior knowledge that should have been acquired within the learning environment in order to successfully achieve the action performance	Assessing the difference between internal and external corporate communication; naming at least three types of messages for internal and external communication.
PRECONDITIONS	Competencies or prior knowledge necessary to the action but that do not belong to the learning environment's scope	Proficient use of MS Word (or other text editor)
INPUT	Object or materials that are provided for the action, but not listed as tools	Acme Web site <a href="http://www.acme.com">www.acme.com</a>
EXPECTED OUTCOMES	The expected learning outcome related to the learning goals, in terms of goal or sub-goal achieved	Understand, analyse and evaluate a corporate communication policy statement according to effectiveness, efficiency and viability
SIDE-EFFECTS	Competencies or knowledge acquired through the action but not directly addressed by the action (or course) objectives	Advanced skills with MS Word.
OUTPUT	The material product or object designed, developed or realized during the action	A report of 20 pages submitted via email
PROCEDURE	An analytic description of how the action is to be performed, including specific tasks for each role	Present the case study ("ACME corporate policy") with the related question sheet. Divide students in groups of three and (...)
LOCATION	The location(s) in which the action takes place (may use ANYWHERE)	A34
TOOLS	The tools exploited in the action.	ACME case study, ACME question sheet
GOAL REFERENCE	The goals general learning towards which the action moves the learners, although maybe not achieving them completely (reference the <i>goal statement</i> OR use predefined values: PREC for <i>prerequisite</i> , TRAN for <i>transfer</i> , EVAL for <i>evaluation</i> , INFO for <i>course information</i> , MOT for <i>motivation</i> )	G1, G7

Table 2.3 - Action diagram definition table

A general notation rule is the following: any area that would be empty is marked with a hyphen (-). According to the definition of action, the only mandatory areas are those in the identification group.

*Remarks: Types, States, Procedures and Goals*

The definition of actions (the core class of the E<sup>2</sup>ML information model) presents some features that are discussed in the following paragraphs.

#### Learning and Support Actions (Action Type)

The action identification distinguishes between *learning* and *support actions*. Learning actions are directly concerned with the learners' progress with the instruction, such as lectures, discussions, exercises, personal study, etc. Support actions concern the staff's work for the instruction, such as correcting and evaluating the submissions, setting up materials, solving logistical issues, etc. Support actions may have no reference to the learning goals, and a minimal definition of the initial and final states.

IMS Learning Design (IMS 2003a) defines support actions as actions that are performed in order to support some role, and therefore "the support activity has to be repeated for every user in the

supported role before it is completed. This is a key difference from learning activities which (are) only performed once". E<sup>2</sup>ML does not reproduce this definition as it holds only for learning activities such as lectures or class events, and only if support activities are targeted to the individual learner. On the contrary, a learning activity may be the individual development of a report (in which case the action is repeated by every single learner), and a support activity may be a class discussion of the results of an exam, or group tutoring.

### Initial State and Final State

The definition of the initial and final state may appear somewhat complicated, but allows a great flexibility and precision. The three rows crossing the initial state area and the final state area describe different types of knowledge or conditions:

1. *Prerequisites* and *expected outcomes* describe the learner's starting and arrival points in terms of knowledge in relation with goals. Prerequisites are essential and necessary conditions for the learner to achieve learning.
2. *Preconditions* and *side effects* describe the learner's starting and arrival points in terms of knowledge that is not related to the goals. Speaking English may be a precondition for entering a course in Game Theory, and a side effect of that course would be improved English fluency – yet language skills are not directly bound to Game Theory as such. Preconditions are accessory yet necessary conditions for learner to take part to the instruction.
3. *Input* and *output* describe the learner's starting and arrival points in terms of objects used and produced. A typical input may be text and a typical output its summary, written by the students. While output descriptors catch all what is produced within a course (a project, artifacts, texts, presentations, etc.), inputs may partially overlap with tools. Nevertheless they are necessary for at least two cases:
  - a. Simple objects that are not listed with the tools, as they do not require any design and development effort (such as simple text copies).
  - b. Output products that are used as input in the following actions (such as a paper project used afterwards for developing a Web site).

Prerequisites, preconditions and inputs are necessary conditions for the action to take place effectively in terms of learning – the action may also take place without some prerequisite, as it often happens, but this would hinder learning.

### Procedures

The performance description can be done in different ways according to the necessary degree of detail, for example by describing the single events or act, by stating tasks for each role involved, or by a more formal description such as a Landamatics algorithm or heuristic method.

A simple checklist for procedure description is the following one (taken from Dick, Carey & Carey 1996):

- Goal presentation
- Motivation management
- Content presentation (what content, with what tools and media)
- Examples
- Feedback
- Grouping criteria
- Test and assessment
- Transfer and retention

Other schemas could be defined for different instructional strategies, such as problem solving, case studies, etc. The procedure area may contain any natural language text, so that any guideline for procedures may be implemented in E<sup>2</sup>ML. It is good practice to indicate the (expected) duration of the action in the procedure field.

### Goal References

The reference to goals is achieved via the identifier tag specified in the goal statement. Interestingly, these are outside the main action box, and do not coincide with the *expected outcomes* description. Indeed, the expected outcome for an action could be a sub-goal, or even simple knowledge about how the course is done, thus not directly related to any learning goal. The idea is that an action does not *achieve* a goal, rather simply pushes or helps learners toward it. So the main course goals are up to the learners, actions simply provide a mean to move toward them.

Moreover, some predefined goals can be indicated, and are the following:

1. PREQ (prerequisite): that the action deals with specific instruction pre-conditions (e.g. a brush-up technical English workshop for the Game Theory course).
2. TRAN (transfer): the action is aimed at enhancing the transfer of knowledge form the learning context to the real performance context (e.g. introducing a new procedure in the professional environment).
3. EVAL (evaluation): the action serves as evaluation (e.g. the final exam, or a project discussion).
4. INFO (information): the action is conceived for providing information about the instruction itself.
5. MOT (motivation): the action has a specific motivational goal, eventually described with the ARCS model (see Chapter I).

An example is presented in Figure 2.11. It describes an action in a Web design course, where learners, divided in groups, are asked to visit a Website and analyze it by representing it with the W2000 hypermedia design model. A tutor is available for support. The expected outcome is a 10 pages' report. The referenced goals are G3, G4, G5, and G6. Notice that the action can be performed with no location constraints, or in PC129, which is a suggested available location.

<b>Website analysis</b>		WA
Students (all, assigned groups), Tutor		LEARNING
Master the W2000 hypemedia design model	Increased mastery in W2000; critical analysis of a Web site (distinguish good design from errors)	G3 G4
Browsing the Web; Using MS PowerPoint + MS Word	-	G5 G6
The Web site to be analyzed	Analysis report (10 pages max., diagrams in PowerPoint)	
(Group) Visit the assigned Website, reconstruct its content and navigational structure. Represent it with W2000. According with the Web site requirements, identify design inconsistencies and potential usability problems. Write a report according to the guidelines (Tutor – available in defined timespans during the week) provide support and guidance at intermediate states of the analysis. DURATION: 8 hours in the 4 <sup>th</sup> course week		
[anywhere]   PC129		
W2000 specification, course syllabus		

Figure 2.11 – Action diagram example

### *Optional and Compulsory Actions*

Within the instruction, some actions may be optional and others compulsory. A compulsory action should be declared as such in the course syllabus, and it is expected (or it is sensible to expect) that all learners will perform it. This can be guaranteed by rules, assessment systems, etc., such as controlling attendance to the weekly lecture, or requiring learners to submit a report by the end of a daylong workshop. Optional actions are included in the design, but learners are free to perform it (such as

optional readings), or it is unlikely that they all do that (for example, the instructor may suggest taking some time to revise notes every week, but not all students will actually do that). Optional actions are represented with dotted external box border. The following example (Figure 2.12) is a personal study activity from the Web design course of the previous example, which may supposedly have taken place before the Web site analysis activity.

<b>Personal Study (week 2)</b>		P2
All students (in groups or single)		LEARNING
First itroduction to W2000	Being able to read a W2000 diagram.	G3
-	-	G4
Lecture slides, lecture notes	-	
Revise notes, read the examples, formulate questions for the next class and post them in the course forum.		
[anywhere]		
Lecture slides, W200 specification, Forum		

Figure 2.12 - Optional action example

## Resource Lists

Resource lists form the third document set. Lists represent the main difference between the Core and Advanced Version, as they are fully specified only in the latter. In the Core Version lists are basically a collection of the elements used in the action diagrams divided by type, and may be omitted as long as the overview and action diagrams are understandable and self-explanatory.

### *Role & Actor List*

The roles and actors list describes the different roles that the persons involved in the instruction cover, indicating the name of the role, and who is going to perform it.

An example of a standard West-European academic course is:

- Professor (George Armin).
- Assistant (Mark Basil; Fanny Coleman).
- Student (120 freshmen).
- Technical support (John McCullogh).

The list could be extended with information taken from the learner characteristic analysis performed during the project.

The role and actor list is a support in checking that all activities are designed for the right target (the learners) and supported by professionals with adequate preparation. It may also be used to check that the profiles of the people involved match with the duties they are assigned. Moreover, a cross reading with action diagrams may reveal eventual work overloads.

### *Location List*

In the Core Version, the location list collects the names of the location in which the activities will take place. The following is an example of a blended-learning course:

- Classroom 1006.
- Computer Lab C12.
- Students' home.
- Instructor office (for personal discussion).

The location list is useful as a checklist to verify that every activity can take place in a suitable space and with the support of the necessary facilities. Moreover, it may be used for checking that no overlapping reservations exist.

### *Tool List*

The last list in the resource list document set is the tools list, which collects descriptions of the tools that are exploited in the educational environment. A tool is different from a facility, as it does not belong to a specific location. Consequently, what is a tool and what a facility varies according to the situation: a microscope may be a facility in one school, as it cannot be moved from the lab, whereas it is a tool in another, where it is installed on a trolley and can be reserved and used by any science teacher in any room.

Notice that not all tools must be specified in the tool list. Some of them may simply appear in the input field in action diagrams. The tool list is especially useful for tools that require specific design and development, or adaptation, or that should be reserved or prepared for the activity.

The example in Table 2.4 is taken from an on-campus blended-learning academic course in Java programming exploiting the Web as delivery medium.

NAME	DESCRIPTION
Course script	Xeroxed copies of the instructor's notes + reference texts
Slides package 1	PDF files of the slides for the first 4 weeks
Slides package 2	PDF files of the slides for the last 4 weeks
Online dictionary	Lookup tools for key definitions (HTML pages)
Java parser	Online Java parser + downloadable version
Course website	Website collecting: Slides package 1, Slides package 2, Online dictionary and Java parser
Forum	Online forum

Table 2.4 - Tool list example (core version)

The tool list is a useful reference for checking the implementation status, and can be used for project coordination.

## **Overview Diagrams**

The last document set contains overview diagrams. In the Core Version there are two general views of the whole instruction. In order to improve legibility actions are represented in the overview diagrams with a simple box containing the action identifier tag or name.

### *The Dependencies Diagram*

The dependencies diagram represents the relationships existing among all the actions. The following three types of relationships are represented (see the key in Figure 2.13):

1. Learning prerequisite: the first action provides a (the) learning outcome that is a prerequisite of the second action (e.g. a lecture provides concepts for the following analysis work). Prerequisites relationships between actions are represented by a circle-end arrow.
2. Product: the first action produces as material output some artifact that is required as material input for the second action (e.g. a group-work activity produces a presentation which is shown during the following class discussion). Product relationships are represented by a simple-end arrow. Product arrows may be tagged with the product (e.g. report).

3. Aggregation: an activity is part of another activity (it is a sub-activity). Aggregations are represented by nesting aggregated actions in the main action box.

Moreover, actions can be grouped into *trails*, or logical groups of actions, such as all lectures, or all the actions that form a specific activity in a course, etc. Trails are represented by rounded corner boxes.

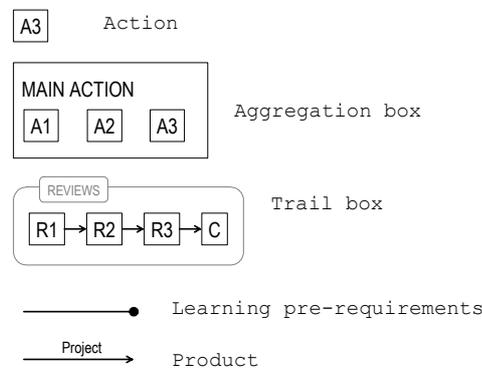


Figure 2.13 - Representation key for the dependencies diagram

An example is reported in Figure 2.14. It represents a possible solution for the Web design course.

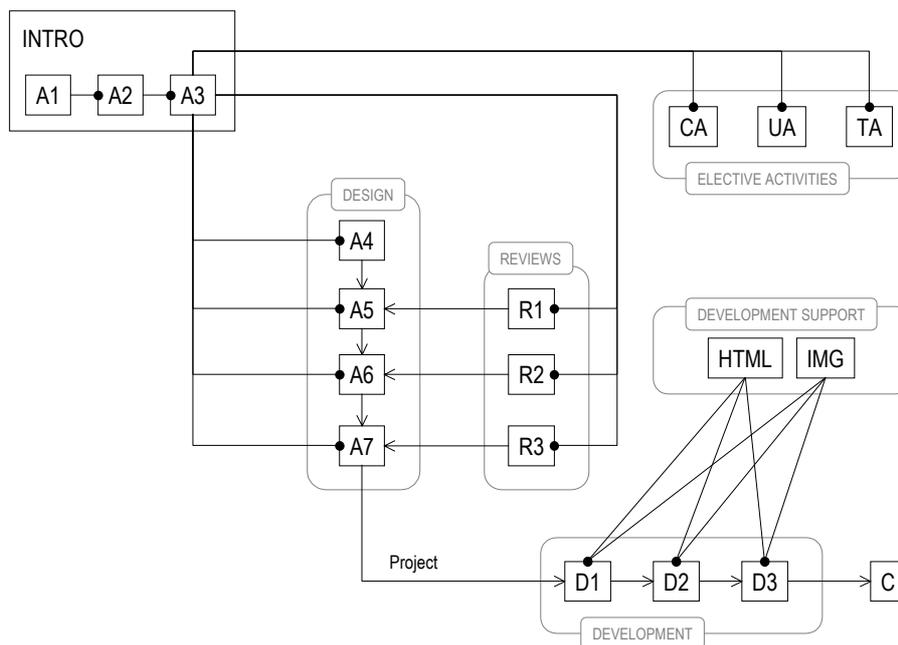


Figure 2.14 - Dependencies diagram notation example

In order to understand it, all the previously defined document sets should be available – yet some imagination can in this case provide enough support.

The course is organized in an introduction, composed by three main actions; four guided design activities (grouped into a trail); three reviews (also grouped into a trail), three development sessions

(another trail), and a final conclusion. Moreover, three elective activities are foreseen, each a different kind of Web site analysis: Content Analysis (CA), Usability Analysis (UA) and Technical Analysis (TA). Finally, two support actions are available for supporting the development phase, concerning HTML coding and digital imaging.

A3 is a prerequisite for all the guided design and review activities; implicitly A1 and A2 are also necessary, as they are prerequisites for A3 (A1 for A2, and A2 for A3). There is a product flow from A4 to C (the paper project and then the demo implementation). Reviews also provide a product to the design actions (comments and corrections).

Doubt may arise deciding if using aggregation or trails for nesting actions. Although they might look similar, they present an important difference. Aggregations represent actions with their parts, so that a main action must still represent a unitary action, with the same subject and the same goal. Trails, on the other hand, are more functional groupings, and can be freely defined by the designer. They could represent all face-to-face sessions, or videoconferences, or all the activities with the same format, despite they have different goals and are performed by different subjects.

Notice that this diagram does *not* tell anything about the actual sequence of actions in the course. Clearly, if actions are well sequenced, prerequisites and product relationships will be respected. Let's take an example: the reviews (R1 to R3) will probably take place in alternation with design activities (A4 to A7), and this is not represented here.

The dependencies diagram is a powerful tool both for design and for re-design during course enactment. Its use will be shown in the case studies in Chapter IV.

### *The Activity Flow*

The activity flow is a visualization of the instruction calendar: it is a flowchart diagram that represents each learner's path through the instruction.

Actions are therefore sequenced, eventually ordered into more parallel branches. Each action can take place at a defined moment in time (a particular date/time) or be allocated for free execution within a defined timeframe. A simple line connects actions to each other. Double-ended arrows are used for representing timeframes for execution (see below the representation key).

In order to make it more useful, the instruction can be divided into phases, which are reported in the action flow, such as course introduction, classes, final reporting, rehearsal, etc. An even greater level of detail can be reached by representing the action flow on an adequate time grid (e.g. days, weeks or months) on which all action instances are represented.

The following split and branch controls can be added to the flow (in brackets the key id):

1. Conditions (IF): splits based on conditions (e.g. the learner's average mark is more than 7.5 out of 10, or the learner is not English mother tongue).
2. Options (SELECT): unconditioned splits in which learners may choose one out of a number of actions.
3. Selections (AT LEAST X [MAX Y]): multiple splits (or N-out-of-M splits), which represent the learner's possibility to select a certain number of activities out of a given set (e.g. at least 2, maximum 4 activities out of the 6 proposed).
4. Parallel activities (ALL) splits where all branches have to be completed or all actions to be executed.
5. Any-order actions: branches in the activity path where a number of activities should be completed in any order.

The diagram representation of all splits is an ellipse containing the key id for each split type. Specific notation can be added on the outgoing branches of each split for clarifying their meaning, e.g. condition statements. An exception is made for any-order actions, which are represented within a rounded-corner box.

Joins are also used for a sound notation of splits. For simplicity's sake, E<sup>2</sup>ML defines only a generic *join* element, represented by a filled oval. The complete semantics of each joint can be annotated beside the oval.

The representation key for the activity flow is summarized in Figure 2.15:

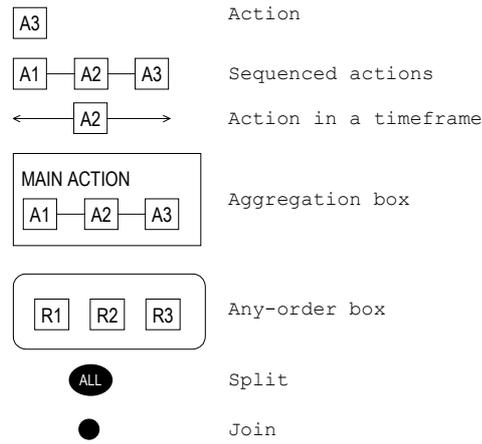


Figure 2.15 - Representation key for the activity flow

The following example (Figure 2.16) presents an activity flow with most of its formal features: the instruction lasts nine weeks, starting with A1. After that learners have to choose one among A2, A3 and A4. During week 3 and 4 learners must perform A5, A6, A7, in any order. Then the instruction continues in two branches, where students are divided according to the result achieved in A6. The instruction is then concluded by A11 and A12.

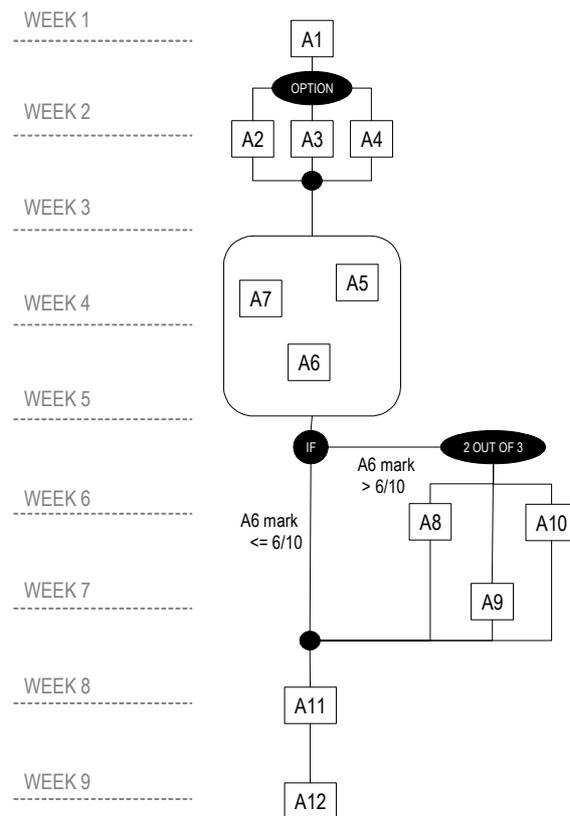


Figure 2.16 - Activity flow formal example

Although not tightly bound to any usual control flow notation system, the structure of the splits and their notation was specifically conceived for making these flow control elements easily manageable and extendible. A more detailed comparison between E<sup>2</sup>ML flow representation and other flow control languages is offered in Chapter III.

Figure 2.17 presents the activity flow of the Web design course. It must be read from top to bottom and from left to right. From a formal viewpoint, this diagram is less articulated than the previous example, and should be taken as a “light version”, easier to manage although less precise. The dotted lines divide the flow into phases (without dates), whose names are annotated on the left. In order to enhance legibility, no dates have been indicated, both for phases and actions.

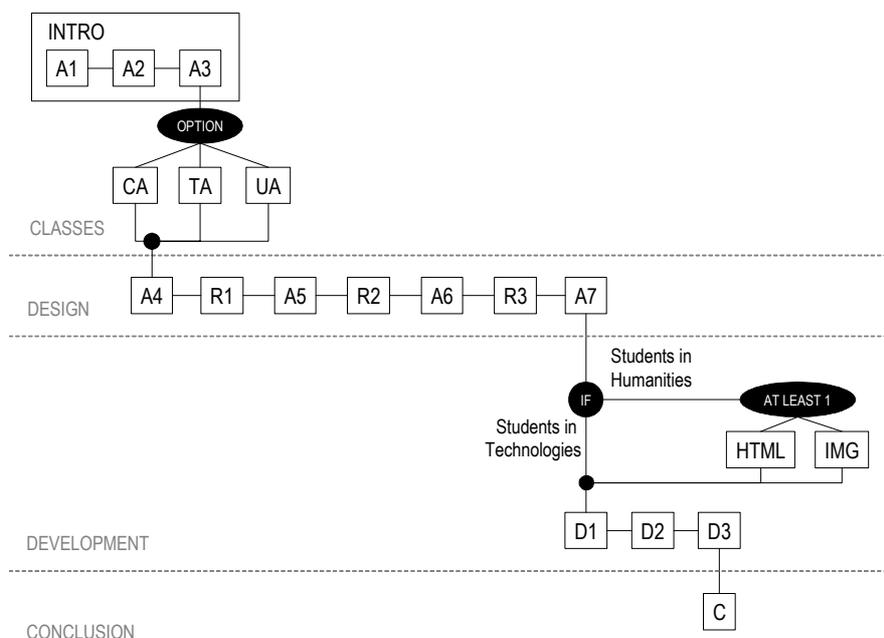


Figure 2.17 - Action flow example

The example clearly shows that the activity flow provides complementary information to the dependencies diagram. First of all, it is evident here that the elective activities are intended as a list from which each learner should select one. Secondly, reviews are actually placed in alternation with design activities. After the design phase is concluded, students in Humanities may choose one or two (all) of the development support activities before the development phase, while students in Technologies directly proceed to that. Finally, the conclusion comes directly after the development activities.

Obviously, the correct basis for a consistent design of the activity flow is the dependencies diagram: prerequisite and product relationships should be maintained in scheduling the activities. While this may sound trivial, setting up a good calendar may not be easy, especially when forced by agenda constraints, classroom reservations, or by the invitation of external speakers.

## E<sup>2</sup>ML Advanced Version

E<sup>2</sup>ML Advanced Version provides more structured tools for the description of an educational environment, which may offer a stronger support for:

1. A formal project management approach to the design process.
2. The integration of technology standards in the design process.

On the other hand, the production of Advanced Version documentation requires a larger time investment and more technical competence. The Advanced Version includes all the elements of the Core Version, and extends it with:

1. Two features of action diagrams.
2. Structured specifications for resource lists.
3. The Course Breakdown Statement (CBS).

The following paragraphs cover the four document sets indicating the new features of the Advanced Version with respect to the Core Version.

## Goal Definition

The goal statement and goal mapping remain the same in both versions.

## Action Diagrams

The Advanced Version adds two features that make action diagrams more expressive.

### *Action Instances and Action Types (Inheritance)*

Action diagrams in the Advanced Version can be used for representing action instances or action types. Action instances are single (individual) actions, identifiable as a defined event in the educational environment, with a specific time span. They are represented exactly as shown above in the Core Version. The name of an instance action is underlined.

An action type is a general description of a specific *kind* of action (a class discussion, or a lecture); as such it can be used as a model or blueprint for defining instance actions (or action sub-types). More precisely, action types may be used to define common patterns of action that can be inherited by action instances (or other action types). Moreover, they can be exploited as general action models for reuse.

The general action structure remains the same for action types, with some differences:

- Some areas may be blank (indicated with [...]), or bear only generic references (included in square brackets). Blanks and generic references will be filled when creating action instances from the action type.
- The action type name is *not* underlined.
- Action types may not have any goal reference.
- An action type tag may include a lowercase *x* as the slot for a character or a string that will identify a specific action instance derived from that type.
- Action types may be optional or compulsory.

The relationship between an action type and an action instance (or other derived action type) is called *inheritance*, and is represented with a triangle-end arrow, from the inheriting action (type or instance) to the parent action (the type).

The following example (Figure 2.18) is taken from a course in Organization Theory, and shows the general diagram for the action type *lecture* and the inheritances for two action instances *lecture 2* and *lecture 12*, referencing different goals. The diagrams show that all lectures involve all students, the instructor and the assistant; moreover, all of them will take place in Classroom A21, and all will use lecture slides, although different for each lecture. Lectures do not require any input and do not produce any output. Instance actions define what slides are actually used and specify the topics covered, the initial and final state, along with goal references.

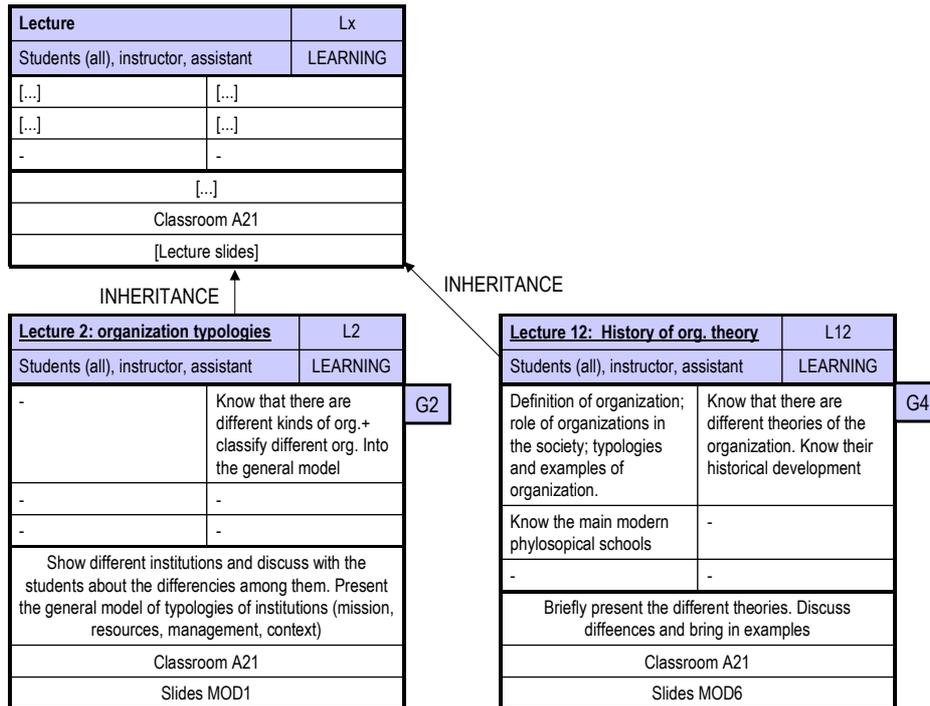


Figure 2.18 - Action inheritance example

### Composite Actions (Aggregation)

Both action types and instances can be related by aggregations. This indicates that one action is composed by two or more sub-actions. “Part actions” (or aggregated actions) represent a sort of more detailed view of the “whole action” (main action), which can be divided for example in a sequence of smaller actions. Notice that:

- Action types may be aggregated only to action types, and action instances only to action instances.
- Aggregated actions have the same goals as (or a subset of) the main action. If no goal reference is indicated for aggregated actions, this means they have the same goals as the main action.
- The roles, location and tool areas of aggregated actions always contain a subset of the same field in the main action<sup>10</sup>.
- Actions inheriting from a main action, also inherit its part structure.

Aggregation is represented with a square-end arrow, from the “part” actions to the “whole” action. The following example (Figure 2.19) refers to the Web design course. It shows the main instance action *Web Site Development* and three of its parts, namely the introduction to the activity, the design phase and a review with the assistants.

<sup>10</sup> From a logical and formal point of view, this should be applied to all areas. Nevertheless, the initial and final states could be expressed differently: being too formal on this point may make the use of aggregations more a burden than a help to creative design.

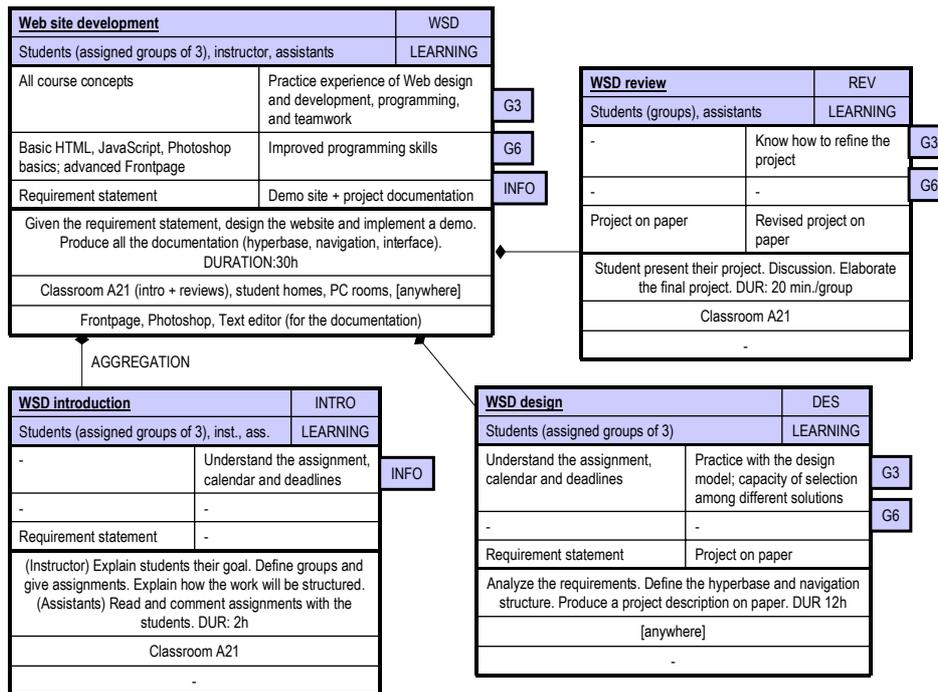


Figure 2.19 - Action aggregation example

Aggregations are also represented in the dependencies diagram, both in the Core and Advanced versions. Clearly, the two representations must be consistent. The reproduction of aggregations in the dependency diagram is an additional tool for a more detailed specification of sub-actions.

### Modular Structures

Action types and aggregations can be used for representing modular structures, which are very common in Higher Education or in any situation where courses are scheduled on a weekly or otherwise periodical calendar, or foresee determined activity formulas, such as lectures, discussions, seminars, etc. A weekly module can in fact be represented as an action type, composed by any number of parts, which would be other action types. Weekly module instances would be therefore composite action instances inheriting from the weekly module type. The case studies expressed with the advanced version will illustrate such a process.

### Resource Lists

E<sup>2</sup>ML Advanced Version defines for each resource list a tabular structure of the attributes specified for each resource (roles, locations and tools). On the one hand, this may hinder creativity; on the other, it may support designers in the effective management of complex situations. The definition of resources lists is the basis for the formalization of the E<sup>2</sup>ML Information Model presented in Chapter III. Notice that for each resource a unique identification tag is defined. Action diagrams in the Advanced Version should use these tags in their locations, tools and acting subjects fields.

### Role & Actor List

In the Advanced Version role & actor list each role has a tag, a name, and a description of the related functions. The main distinction between roles is their type, which can be *learner* or *staff*. The basic distinction may be detailed with sub-distinctions (e.g. technical staff or teaching staff; full-time learner or part-time learner; etc.). It can be indicated how many persons will cover a specific role (e.g. 3

tutors, or 1 instructor) and by whom. More persons can cover one role, and the same person may of course cover different roles.

The list is formed as in Table 2.5:

ROLES and ACTORS		
ELEMENT	DESCRIPTION	EXAMPLE
TAG	A unique identifier (used for reference)	A
ROLE NAME	The complete name for the role	Teaching Assistant
TYPE	Indicates if staff or learner (values: STAFF or LEARNER)	STAFF
DESCRIPTION	A short description of the functions associated to the role	Holds class exercises, provide counselling to students
NUMBER	The number of persons covering the role	1
[ACTORS]	Who covers that role in the actual learning environment	Bob Newell

Table 2.5 – Role & actor list definition table (advanced version)

Other elements from the learner characteristic analysis could be included if useful for the specific project. The example of a standard West-European academic course reported above would be expressed as in Table 2.6:

ROLES & ACTORS					
TAG	ROLE NAME	TYPE	DESCRIPTION	#	ACTORS
P	Professor	Staff	Holds lecture	1	George Armin
A	Assistant	Staff	Provides counselling, answers questions, helps correcting exams	2	Sabrina Keller, Judy East
S	Student	Learner	Student	160	On-campus freshmen
T	Technical support	Staff	Provides technical support with online materials	1	Steve Ogilvy
F	Feedback gathering	Staff	Revises online feedback, interviews professor and students for further feedback	1	Sabrina Keller
E	Evaluator	Staff	Evaluates exams	1	George Armin

Table 2.6 - Role & actor list example (advanced version)

### *Location List*

The location list collects the descriptions of the physical places where the educational activities take place. Each location is referenced with a tag and a name, and described giving relevance to the facilities. Some notes about the use of the location may be added, concerning special reservations, or how to ask for a particular setting of the available facilities, etc. Like all lists, this simple description can be detailed according to case specific needs. The table is thus formed as in Table 2.7:

LOCATIONS		
ELEMENT	DESCRIPTION	EXAMPLE
TAG	A unique identifier (used for reference)	A34
NAME	The location name	Classroom A34
DESCRIPTION	A short description of the location	Classroom with max. 50 places + instructor
FACILITIES	Facilities available at the location	PC, LAN Internet connection, beamer, whiteboard, flipchart. An additional laptop can be connected. 34 places on frontal desks.
[NOTES]	Other notes for usage	Already reserved by the administration. Remember to bring pencils!

Table 2.7 - Location list definition table (advanced version)

An example of a standard Informatics course is reported below in Table 2.8:

LOCATIONS				
TAG	NAME	DESCRIPTION	FACILITIES	NOTES
A21	Classroom A21	Classroom with max. 200 places with frontal desks (3 students per desk) + instructor. Quite warm in Summer.	PC, LAN Internet connection, 3 microphones, PC audio output, beamer, whiteboard, flipchart An additional laptop can be connected	Already reserved for regular classes by the administration. Ask the administration (via email) for additional sessions.
PCR1	PC room 1	PC room with 40 places + one for the instructor	Fully equipped PC, LAN Internet connection – need headphones for audio	Free access. To be reserved for lab sessions.
PCR 2	PC room 2	PC room with 24 places + one for the instructor	Fully equipped PC, LAN Internet connection – need headphones for audio	Free access. To be reserved for lab sessions.
H	Student home	Students home	(90% of the students have an Internet connection; 20% high speed)	-

Table 2.8 - Location list example (advanced version)

Differently from other models, E<sup>2</sup>ML puts a special emphasis on the physical locations, not only on tools. Actually, the availability and suitability of physical spaces is an utmost relevant element in education – just think of the impact that a frontal disposition of desks may have on a collaborative problem solving session. In this direction (indeed not a new one, yet often forgotten) some interesting program is trying to combine Instructional Design, Pedagogy and Architecture for developing flexible and practical spaces for specific instructional strategies (see e.g. Cavenagh 2002).

#### *Tool List*

The description of technology-dependent tools is greatly enriched in E<sup>2</sup>ML Advanced Version. Each tool is described by a tag and a name, a description, notes on its availability and eventually by an indication of the person in charge for managing it and/or providing support (both the person or the role can be referenced). Each tool belongs to a specific *class* of tools, which identifies its type. E<sup>2</sup>ML defines the following tool classes<sup>11</sup>:

1. Content: an object serving as support for some content, such as a book, a set of slides, or the instructor's notes.
2. Instrument: properly a tool for performing or enabling specific actions, such as a microscope, scissors, or a code parser.
3. Service: the same as an instrument, with the difference that it should be re-instantiated for each single edition of the instruction. A microscope can be used in the 2002 Chemistry course, and

<sup>11</sup> Classes were taken from IMS Learning Design specification (IMS 2003a), with the addition of new classes.

then reused for the 2003 edition. An online forum is also used in both editions, but it is not the same one: the 2002 one will be archived and a new forum will be instantiated (probably with the same features) for the 2003 version.

4. Test: objects created on purpose for the assessment of learning, such as a multiple-choice sheet or a self-assessment exercise.
5. Guideline: a description of how an activity should be performed, such as a group work or an analysis.
6. Collection: a grouping of more tools (eventually of different classes), such as a course Web site, or the course script.

The table is therefore defined as in Table 2.9:

TOOLS		
ELEMENT	DESCRIPTION	EXAMPLE
<b>TAG</b>	A unique identifier (used for reference)	FC
<b>NAME</b>	The tool name	Feedback collector
<b>CLASS</b>	The class of the tool: CONTENT, INSTRUMENT, SERVICE, TEST, GUIDELINE or COLLECTION.	SERVICE
<b>DESCRIPTION</b>	A short description of the tool	Online survey collector at <a href="http://www.url.edu">www.url.edu</a> ; results available under <a href="http://www.url.edu/res">www.url.edu/res</a> (with password). Feedback is collected via an online form with 10 multiple-choice questions.
<b>AVAILABILITY</b>	If the tool is available + notes	Available (custom tool, no licence required)
<b>[MANAGER]</b>	Who manages the tool (e.g. for customisation or upgrades)	Peter Thompson
<b>[SUPPORT]</b>	Who provides technical support	Peter Thompson

Table 2.9 - Tool list definition table (advanced version)

The following example (Table 2.10) completes the on-campus blended-learning academic course in Java programming presented above.

TOOLS						
TAG	NAME	CLASS	DESCRIPTION	AVAILABILITY	MANAGER	SUPPORT
CS	Course script	Content	Xeroxed copies of the instructor's notes + reference texts	In the instructor's office (office hours)	Peter Jones (tutor)	-
SP1	Slides package 1	Content	PDF files of the slides for the first 4 weeks	In CW	Peter Jones (tutor)	-
SP2	Slides package 2	Content	PDF files of the slides for the last 4 weeks	In CW	Peter Jones (tutor)	-
OD	Online dictionary	Tool/content	Lookup tools for key definitions (HTML pages)	In CW	Mark Hammond (instructor)	Peter Jones (tutor)
JP	Java parser	Tool	Online Java parser + downloadable version	In CW	-	Peter Jones (tutor)
CW	Course website	Collection	Course website collecting: SP1, SP2, OD, JP	Available at <a href="http://www.ex.edu">www.ex.edu</a> (hosting: edu6 server)	Peter Jones (tutor)	Peter Jones (tutor) + Frank Jay (server admin)
FOR	Forum	Service	Online forum	From CW	Peter Jones (tutor)	Frank Jay (server admin)

Table 2.10 - Tool list example (advanced version)

## Overview Diagrams

The dependencies diagram and the activity flow are the same in the Core and Advanced versions. The Advanced Version extends overview diagrams by introducing the course Breakdown Statement (CBS). Notice that once introduced the distinction between action type and instance, overview diagrams only consider action instances.

### *Course Breakdown Statement (CBS)*

Project management best practices suggest producing a list of all the tasks and subtasks. E2ML Advanced Version defines the Course Breakdown Statement (CBS) as a list of all action instances. The list reports a subset of the definition of actions, as in Table 2.11:

ACTIONS (CBS)		
ELEMENT	DESCRIPTION	EXAMPLE
TAG	The action tag	INTRO
NAME	The action name	WSD Introduction
TYPE	The action type	Learning
ROLES	The action involved roles (acting subjects)	Student (assigned groups of 3), assistants, instructor
LOCATIONS	The action location(s)	A21
TOOLS	The action tool(s)	Multimedia case studies
DURATION	The action duration	2h

Table 2.11- ABS definition table

Actions in the CBS may be ordered by date, if the instruction schedule has already been planned. Table 2.12 reports a short example taken from a seminar on Institutional Communication. The seminar, for 12 learners, foresees three lectures, an online discussion moderated by a tutor on two different topics, and a face-to-face concluding session. The evaluation is done on the basis of personal participation and contribution to the discussion.

ABS						
TAG	NAME	TYPE	ROLES	LOCATIONS	TOOLS	DUR
L1	Lecture 1: Seminar introduction: the role of institutions	Learning	Lecturer, learners (all)	A21	Slides 1, videotape	2h
L2	Lecture 2: New Public Management	Learning	Lecturer, learners (all)	A21	Slides 2	2h
L3	Lecture 3: Institutional Communication	Learning	Lecturer, learners (all)	A21	Slides 3	2h
GW	Metaphors of the organization: discussion	Learning	Lecturer, learners (in pairs)	A21	Copies of the text	4h
F1	Forum discussion 1 (metaphors)	Learning	Students, tutor	[Anywhere]	Forum	2h
F2	Forum discussion 2 (NPM)	Learning	Students, tutor	[Anywhere]	Forum	2h
CON	Concluding lecture	Learning	Lecturer, learners (all)	A21	-	2h
EV	Evaluation	Support	Lecturer, tutor	[Anywhere]	Forum	3h

Table 2.12 - ABS example

The CBS is a first synthetic view of all actions. It can be useful e.g. for checking the development status of each action, or the workload for each role, thus avoiding overloading.

## Summary

E<sup>2</sup>ML was presented as a collection of four document sets, each of them including a number of documents, specified into two versions. The complete collection of the four document sets in any version would fully describe an instructional unit, module or course according to the model. The Advanced Version offers more details in a more structured way than the Core Version.

The document sets, the documents, and some detail about them in the two versions are reported in the wrap-up Table 2.13.

DOCUMENT SET	DOCUMENT	CORE VERSION	ADVANCED VERSION
GOAL DEFINITION	GOAL STATEMENT	List	SAME AS CORE VERSION
	GOAL MAPPING	Visual model (QUAIL model)	SAME AS CORE VERSION
ACTION DIAGRAMS	ACTION DIAGRAMS	Single actions <ul style="list-style-type: none"> <li>▪ Compulsory/Optional</li> </ul>	SAME AS CORE VERSION + <ul style="list-style-type: none"> <li>▪ Inheritance</li> <li>▪ Aggregation</li> </ul>
RESOURCE LISTS	ACTOR & ROLE LIST	Loose List	Structured List
	LOCATION LIST	Loose List	Structured List
	TOOL LIST	Loose List	Structured List
OVERVIEW DIAGRAMS	CBS	NO	List of actions
	DEPENDENCIES DIAGRAM	<ul style="list-style-type: none"> <li>▪ Prerequisites</li> <li>▪ Products</li> <li>▪ Aggregations</li> <li>▪ Trails</li> </ul>	SAME AS CORE VERSION
	ACTION FLOW	<ul style="list-style-type: none"> <li>▪ Conditions</li> <li>▪ Options</li> <li>▪ Selections</li> <li>▪ Any order actions</li> </ul>	SAME AS CORE VERSION

Table 2.13- E<sup>2</sup>ML document sets summary table

The document perspective used in these pages reflects how E<sup>2</sup>ML is instantiated in the design process. Once more notice that the language should not be intended as a set of rules, rather (and this is indeed its real nature) as a toolbox for improving design. As such, designers should feel free to take the parts they feel comfortable with, extend them and rearrange them according to their purpose.

The next Chapter will discuss E<sup>2</sup>ML identifying its sources and comparing it with Instructional Design models and other disciplines. Chapter IV will propose several case studies that will show E<sup>2</sup>ML in action in real design processes. Finally, Chapter V will introduce some elements for a preliminary evaluation of the language.

## CHAPTER III

# E<sup>2</sup>ML IN CONTEXT

*"Planning is everything, the plan is nothing."*

*(General Eisenhower, 1944 - quoted in Bates 1995)*

Chapter III discusses E<sup>2</sup>ML in its proper interdisciplinary context. In the “About E<sup>2</sup>ML” section, it is approached from within, presenting a complete analysis of its sources and main use scenarios. After that, E<sup>2</sup>ML is approached “from the outside” in three sections, each taking the perspective of a different discipline. The first section compares E<sup>2</sup>ML to other Instructional Design models: its goal is to show how it can be integrated into the design process, and with what advantages. The middle section is focused on a formal comparison of QUAIL and E<sup>2</sup>ML with two IMS standards: Reusable Definition of Competence or Educational Objective (RDCEO), the specification for the representation of learning goals, and Learning Design (LD), which is the only other language for a formal a representation of instruction. The final section provides some elements for framing E<sup>2</sup>ML within the context of flow control languages and Process Design: the representation of education is the representation of a specific process, and E<sup>2</sup>ML takes advantage of some tools in that discipline.

Notice that the following pages are not an exhaustive description of all the possible uses of E<sup>2</sup>ML. It is in fact a language, and it may be used freely and for different purposes. Some designers may decide to use overview diagrams for brainstorming, leaving apart the details specified in the resource lists and action diagrams. The case studies in Chapter IV will provide several examples of such adaptation. The goal of this Chapter is rather to define a paradigm of usefulness and to see what interfaces and contact points with other existing tools E<sup>2</sup>ML has.

The main assumption is that E<sup>2</sup>ML alone is *not* a complete tool for Instructional Design. As a representation language, it may support the complexity within the design activity, but the structure of the design activity itself should be defined elsewhere, and other specific tools should be used in some of its phases.

## About E<sup>2</sup>ML

### Sources

The review of Instructional Design models presented in Chapter I confirmed that E<sup>2</sup>ML is a unique attempt in this field. The independent research presented in (Morimoto et Al. 2003) draws the same conclusions on this point. It is therefore interesting to see what disciplines, a part from Instructional Design itself, influenced its development.

E<sup>2</sup>ML is a specialized process design language, tailored to the needs of education. The activity flow and the dependencies diagram reprise respectively flowcharts and PERT diagrams. The Course Breakdown Statement is an adapted version of a Project Breakdown Statement. The fourth section of this Chapter will provide a more detailed comparison between the E<sup>2</sup>ML activity flow and other flow control languages.

Other obvious references are modeling languages, such as UML, W2000, etc. The visualization of design objects is the key for such models and is explicitly considered here.

A third source, probably less evident, is requirement engineering (Sommerville & Sawyer 1997, Von Lamsweerde 2000 and Satcliffe 2002). According to (Bolchini & Paolini 2002), requirements engineering models have three intertwined tasks:

1. Supporting the elicitation of requirements.
2. Supporting analysis and modeling during design.
3. Supporting the negotiation and validation of design.

All of them are goals that E<sup>2</sup>ML is trying to achieve too. From a formal point of view, this work is connected to requirement engineering in at least two ways. Firstly, the modeling of instruction is an implicit requirements specification for the tools developed to support it in terms of scenarios (the actions in which a tool is used are an exhaustive list of possible scenarios for that tool) and goals. Moreover, the goal definition document set is education-specific an answer to the call for lightweight methods for requirement engineering done in (Bolchini & Paolini 2002). From this point of view, the

particular features that E<sup>2</sup>ML reprised are the definition of goals as external to the actions (differently from most Instructional Design Models), the introduction of stakeholders, and goal ranking. A last source, which influenced the semantic definition of action diagrams, is Artificial Intelligence, from which the general notion of action as initial state, final state, goal, actors and resources was taken.

### **A Language for the Improvement of Design**

The main idea underlying E<sup>2</sup>ML is that a design process that can represent and externalize its object can bear more complexity, thus potentially achieving a higher degree of refinement, precision and quality for more articulated problems. As Vygotsky (1978) points out, this is the very nature of human language: a modeling language makes the design process more sustainable and manageable, empowering the creativity of designers. This happens basically for two reasons:

1. Representing the instruction in written form frees the designers from the necessity to keep it all in mind, and offers a way of “forgetting it” for some time in order to re-evaluate the design from a more objective point of view and improve it.
2. A formal model obliges designers not to overlook details, avoiding the occurrence of a sudden realization that “we have completely forgotten that”, but now “other decisions cannot be undone”.

The counterpart is the investment in learning and mastering the language itself, clearly larger for the Advanced Version, yet not negligible also for the Core Version. Moreover, the time required for writing the E<sup>2</sup>ML documentation in each project should be taken into account.

On this point, a complete introduction to E<sup>2</sup>ML for an experienced designer would require no more than a daylong workshop. The case studies in Chapter IV provided evidence that the production of complete Core Version E<sup>2</sup>ML documentation for a course of about 40-60 hours means half a day additional work. The return should be evaluated in terms of quality of education in the long term.

### **E<sup>2</sup>ML & eLearning**

The Introduction presented this work in relation to new media in education. Nevertheless, the attentive reader would probably and correctly wonder where E<sup>2</sup>ML specifically addresses the issue of technologies. The answer is: nowhere. E<sup>2</sup>ML is a modeling language for educational environments that can be used in virtually any case.

The eLearning wave has been a catalyst that actualized a number of changes, mostly in the attitude of educators and in the relationship between education and technologies, which brought to a sort of paradigm shift. The development of E<sup>2</sup>ML is in part due to this new thinking context, as the introduction of technologies in education has generated much more complex design situations, which would get benefit from a modeling language. From a general perspective then, E<sup>2</sup>ML may be useful in all cases in which the design process must cope with high complexity degree. Three particular cases are outlined in the following paragraphs.

### **Potential Contexts of Use: a Sample**

#### *Technology-Dependent Educational Environments (TDEE)*

TDEE are educational environments that owe their structure and dynamic to the existence and availability of technological facilities, and that could not be put into operation without them. In a TDEE, technologies have become an essential part of the system, and a technical failure would block it. While the same goals could be achieved with other means, a definitive technological breakdown

would make it impossible for the *same system* to operate again. The great variety of eLearning systems certainly falls within this category, but other educational systems may be labeled as TDEE, such as a simple lecture that requires a TV set<sup>1</sup>.

Why *technology-dependent* and not *technology-based*? The notion of TDEE also encompasses environments in which technologies do not play the main role, such as in a simple lecture that requires a beamer for projecting animated slides. The lecture is not *based* on technology, but its effectiveness and success depend on technology all the same. Moreover, the definition of TDEE includes non-electronic technologies, such as the overhead projector or photocopies.

This definition can be detailed with two corollaries:

1. Scope of dependency. Technology dependency should be assessed on the correct level, answering to the question “what part of the TDEE is actually dependent on the tool considered?” A TDEE can be in fact intended as a whole institution, a curriculum, a specific course, or a single lecture. Within a lecture, a single pedagogical activity can be technology-dependent. A technological failure has different consequences according to the scope of dependency.
2. The dependency continuum. The dependency on technology is definitely not a binary value (yes/no). It is rather a continuum defined in relation with the redesign cost necessary after a definitive technical breakdown. If the projector lamp burns out, slides could be printed, photocopied and distributed to the students, usually in a very limited amount of time and with a minimal impact on the educational environment. If the Internet connection breaks down during a videoconference lecture, video and audio communication cannot be restored in any way with comparable effectiveness. A telephone call would probably supply for the audio connection, but it does not offer any interactivity tool nor the possibility to show and use shared documents in real time. Notice that costs include both economic and human resources, along with the impact on the overall quality of the instruction.

From the point of view of the educational designer TDEEs raise a number of new issues, first of all the transformation of design into an interdisciplinary team work (Bates 1999). The design activity in a classic classroom setting (with photocopies, chalk and blackboard) was in fact driven by habit, standard guidelines and rules, which entailed seamlessly good practice principles. The more an educational environment is dependent on technologies, the more its design may benefit from E<sup>2</sup>ML.

#### *Reusable and Adaptable Designs*

In a large number of cases, the design of instruction produces a course blueprint that will be implemented for several different editions, with different learners at different times. This raises a number of issues, such as the production of reusable materials, the possibility to implement the same instruction with different people (different learners, but maybe different tutors and instructors), and eventually its adaptation to new locations, larger or smaller classes, etc. (Bates & Poole 2003).

E<sup>2</sup>ML fosters the reuse of instruction, as it externalizes the design result into a hard-copy file with a set of documents. Moreover, it may help identifying instruction sub-modules which could be reused independently, or that should be adapted for new editions. An example is the design of instruction that should fit different groups of learners, such as academic courses with students from different programs, or courses to classes with cultural differences, etc.

#### *Reverse Design and Redesign*

Another interesting situation could be called reverse design, i.e. the reconstruction of a course *ex-post* in order to analyze it, and discover success factors or faulty passages. This may help improving the course for the next editions, and also provide the design community with reports of best practices.

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<sup>1</sup> The definition of TDEE is interesting as it crosses usual historical, or “evolutionary”, categories. The standard chronology of educational environments in the last century starts with the traditional classroom setting, considers then the first distant education experiences at the Open University with paper mail and telephone, reviews TV-transmitted training and finally introduces eLearning. The concept of TDEE includes a lot of those experiences in a longitudinal way: a lecture with an LCD projector is sometimes strictly technology-dependent, as the explosion of the projector’s lamp would make it impossible to show graphs or 3D simulations. Online asynchronous learning is for sure technology based, as it is a Physics lab experiment.

Think of an important introductory course in a University: designed for the 1500 freshmen enrolled every year, it represents a prerequisite for all courses in the following term. Imagine that, by the end of the course, learners achieved successfully half of the goals, while the other half was achieved only by 40% of the students. Where to redesign in order to fix it? And what are the lessons learnt in terms of design? E<sup>2</sup>ML documentation (eventually produced in a process of reverse engineering) would simplify the analysis and offer an easy way to freeze the discoveries into a document that could be shared by all the designers in that institution.

## Using E<sup>2</sup>ML

### *Who Uses E<sup>2</sup>ML?*

E<sup>2</sup>ML was developed for instructional designers, and every effort was made in order to make it usable, understandable and practical to them. In the same way they develop their own jargon – specifying terms as *template* or *blueprint*, or creating expressions as *round disclosure* -, designers should also feel free to take E<sup>2</sup>ML or any of its part, and extend it, adapt it and make it suitable to their problems. E<sup>2</sup>ML can be also used only partially, without exploiting all its features or completely designing only some activities while leaving others more undefined (e.g. designing a single action type for them). The case studies will present some examples.

Novice designers could use E<sup>2</sup>ML as a language for practicing design. From this perspective, having a language means having a possibility to focus on design itself without slipping away to development – which is particularly easy if learning materials are the only visible product of the whole process.

What about students? Should or could E<sup>2</sup>ML visualizations be used with students? E<sup>2</sup>ML diagrams are not conceived for them, in the same way technical blueprints for a two-floor house are not the best support for letting the senior couple that bought it dream about their retirement. Nevertheless, a visualization of the flow of specific activities is proved to enhance student performance in particular settings, such as problem-based learning (Santoro, Borges & Santos 2003). Diagrams could also be used for negotiating some steps in the instruction, and to improve the critical comprehension of the learning process. In order to make them more effective, the style of diagrams should be rearranged and made more appealing. Showing students a complex documentation has major drawbacks: E<sup>2</sup>ML is a design language, and could make them feel uneasy with the educational environment, exactly as you would feel if your automotive agent showed you the technical blueprint of the brakes instead of the pictures of your perspective car.

### *Where to Start?*

E<sup>2</sup>ML does not have a unique access point. It is a language, and as such it can be used with different strategies eventually taken from other Instructional Design models.

Generally speaking, goals should be defined first, while the designer can decide if proceeding bottom-up (resources, actions, overview diagrams) or top-down (overview diagrams, actions, resources). But it is likely that the documentation would be produced in cycles of refinement. Particular instructional patterns or strategies could be selected before starting the design, and goals could be afterward matched to it. Finally, external constraints may force the design process outside the designer's intention. Content is also an issue: any instructor or subject-matter expert is likely to feel much more comfortable if starting from considering a sort of table of contents, or an outline of *what* will be presented in the course. The balance of Instructional Design is strikingly bent to general and content-independent rules as a counterpart of this content-centric view, thus creating a space for pedagogical issues and offering a chance to think of a course from the perspective of the learner's. For this reason instructional designers can be seen as potential change agents in educational institutions. On the other hand, no good instruction can be achieved without high-quality content. Moreover, a designer can do a good job only on content s/he knows, or at least that s/he values (Schwier, Campbell & Kenny 2003).

In short, despite formal models and theories, the design activity as such does not have a unique starting point. This reflects the very nature of human ideas and of human interaction. The flexibility of E<sup>2</sup>ML is an attempt to foster – or at least not to hinder – creative unpredictability and serendipity.

#### *Where are Strategies?*

Some may notice that E<sup>2</sup>ML does not include a definition of the instructional strategy. Although it is flexible enough to represent a great variety of different implementations of different strategies, it does not aim at that.

The definition of an instructional strategy is nevertheless a necessary element for an effective use of any instructional design model or language. Major guidelines, or first principles, for instructional strategies can be found in (Merrill 2002). Further elements for the discussion are provided in the paragraph “The Place for Instructional Strategies” in this Chapter.

E<sup>2</sup>ML also does not propose any criteria or means neither for curriculum development (the definition of *what* is taught in a course) nor for content sequencing. Like for strategies, this is part of a set of high-level decisions that E<sup>2</sup>ML can only report, but not support. The reader can refer to other authors, such as Reigeluth (his Elaboration Theory is presented in Reigeluth 1983, p. 335-381) or Posner & Rudnitsky (1997).

#### *Is E<sup>2</sup>ML All I Need?*

E<sup>2</sup>ML is not a complete tool in itself. Namely:

1. E<sup>2</sup>ML becomes a useful means of expression if integrated within a structured design process. In particular, the use of E<sup>2</sup>ML at the same time supports and relies on the performance of a number of activities (defined as elements in the classic Instructional Design models):
  - a. Analysis activities: needs assessment, learners analysis and task analysis.
  - b. The selection of an instructional strategy (delivery, content selection and sequencing, types of activity and scheduling).
  - c. The design of learning materials.
  - d. The evaluation (formative, summative, and confirmative).
2. E<sup>2</sup>ML provides a sound representation of the instruction; yet, it does not cover all the documentation to be produced in a single project. Other complementary languages could and in many instances must be used such as Web design models for the development of Web resources. The document sets do not collect all the possible documents produced by designers, also because each designer or team has its own way of proceeding.
3. E<sup>2</sup>ML may enhance, but is no warranty of, a structured project management approach to design.

#### *How Much Effort on Design?*

A comparison may provide a possible answer to the question expressed in the heading. Let’s bring in three elements. First of all, any structured design process exploiting a formal language is more expensive than paper-and-pencil design: introducing E<sup>2</sup>ML is therefore cost-effective only in scenarios like the ones mentioned above, where complex issues must be considered at one time. Secondly, teaching is an art, and it cannot be completely and definitely designed, like a program that is then executed and from which no surprise is expected. Finally, in the design of education a small detail may have a great effect in the long run: although designed in a short time, an instructional unit may require several days of effort to the learners, thus being a relevant change factor for them (Schwier, Campbell & Kenny, 2003).

The design of instruction could be intended like the *canovaccio* in the *comedia dell’arte* in the Italy of the XVIII century. The actors of the *comedia dell’arte*, who played the roles of traditional masks in the Carnival of Venice or in other popular celebrations, did not have a script of their part. They simply knew the general plot, the *canovaccio*, such as the following: the servant plans to play a joke on his master, but the mistress discovers it. However, as she has a lover, she does not reveal it to her husband, but, disguised, offers support to the servant. The joke succeeds, but the mistress falls in love with the servant and flees with him, leaving her former lover under the police’s suspicion of being the real author of the joke. Once on the stage, the actors acted in a way consistent with the plot, but their

actions were hectic, reacting to what the other actors said, and introducing new elements – and this was their art.

The designer's and the instructors' art is much the same: a plan can give shape to the interactions with the learners, but improvisation and reaction to the unexpected is the rule – given that the final outcome, or one even richer, is reached.

## E<sup>2</sup>ML & Other Instructional Design Models

The next pages aim at proposing an integration of E<sup>2</sup>ML in the design process as described by some of the models presented in Chapter I. E<sup>2</sup>ML can represent instructional activities through virtually all design phases: it is a language, not a model, and as such it is not prescriptive, but should be conceived as a tool or a communication device to smoothen and improve the design.

E<sup>2</sup>ML was specifically developed for system-level design, and it can be therefore integrated the most successfully with system-oriented models. Models with other scopes will also be considered, both for completeness' sake and for identifying possible further developments.

### E<sup>2</sup>ML & Classroom-oriented Models

E<sup>2</sup>ML was not developed for classroom-oriented models, as their scope is too narrow for such a language to be efficient. Nevertheless, E<sup>2</sup>ML allows different granularity levels, and it can be easily tailored to small activities, such as a discussion or a group work. The following paragraphs will use ADDIE as main reference. The model is reported in Figure 3.1.

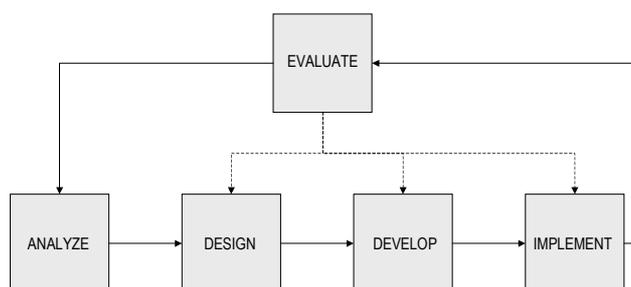


Figure 3.1 - the ADDIE model

E<sup>2</sup>ML can play a role in all phases of ADDIE:

1. In the *analyze* phase, QUAIL and the goals statement can be used for defining the goals of the instruction, and the roles and location lists can collect the results of the analysis.
2. In the *design* phase, the instruction can be represented using all the elements of the language, producing a complete blueprint.
3. The blueprint can be then used both in the *develop* and *implement* phases, for controlling the production of learning materials, and as guidelines for the instructor (action diagrams can actually serve as a sort of session script)
4. The evaluate phase can use the E<sup>2</sup>ML documentation for reviewing the instruction and for identifying possible fixes.

ASSURE (Heinrich, Molenda & Russell 1983), as a media-oriented refinement of ADDIE, can exploit E<sup>2</sup>ML in a similar way.

The other models presented in Chapter I as classroom-oriented models do not directly represent the design process, and their relationship with E<sup>2</sup>ML is consequently different. Motivation is not explicitly modeled in E<sup>2</sup>ML. ARCS guidelines for motivational design (Keller 1983) are an important complement in writing action procedures or in the general definition of the activity flow. Landamatics (Landa 1983) is also concerned with procedures: it would therefore provide a method for defining action procedures or, if the E<sup>2</sup>ML modeling is more fine-grained, for defining action sequences matching the algorithm steps. The same could be said of Gagné's Nine Events of Instruction (Gagné, Briggs & Wager 1962): according to the granularity of design, it should be the designer's concern to assure they all have a proper space within action procedures or a sequence of actions.

### E<sup>2</sup>ML & Product-oriented Models

Product-oriented models are complementary to E<sup>2</sup>ML. While the latter defines the activities and interactions in an educational environment, the formers are specifically concerned with the design of (a part of the) resources. E<sup>2</sup>ML documentation would provide a first structured input for requirement analysis, as already mentioned. The sub-collection of all actions that exploit a certain tool is the implicit definition of all its possible use scenarios within the instruction. Moreover, the actors for those actions are its users, as specified in the action procedures.

For CADMOS-D (Retalis, Papasalouros & Skordalakis 2002), the contribution of E<sup>2</sup>ML would be outside the design activity, in the *hypermedia application description (requirements)* phase (see Figure 3.2).

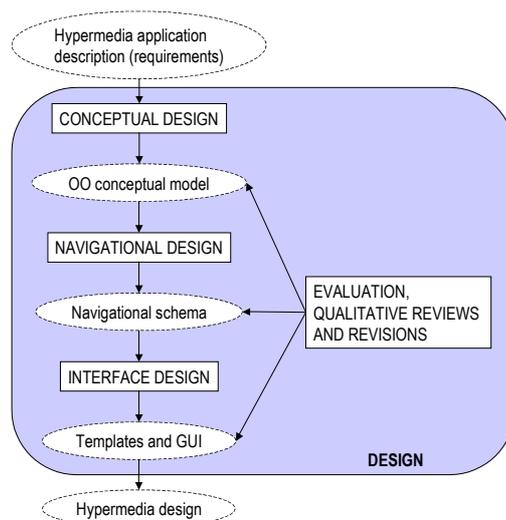


Figure 3.2 - The CADMOS-D model

The same happens for Learning Objects. Designer consistently using metadata would reference them in the tools field of action diagrams, and eventually provide notes about their use in the action procedure. A more specific analysis of the integration of E<sup>2</sup>ML with current learning object standards (in particular IMS RDCEO and IMS Learning Design) is provided in the next section.

### E<sup>2</sup>ML & System-oriented Models

System-oriented models are the natural framework for E<sup>2</sup>ML: the situations and issues that they address are in fact the ones to which E<sup>2</sup>ML is targeted.

### Supporting The Dick, Carey & Carey Model

The Dick, Carey & Carey model (1996) is probably the most refined streamlined representation of the instructional design process. The benefits that E<sup>2</sup>ML may bring to it are similar to those discussed above in relation to ADDIE, although more deciding. While in fact the very decision to use E<sup>2</sup>ML for classroom-oriented design would be seldom efficient, the typical complexity of system-level design (just think of the number of phases, or of the different profiles in the design team) makes its exploitation the key for a more manageable, flexible, effective and efficient process. Figure 3.3 shows the possible integration. Bold-border E<sup>2</sup>ML boxes indicate phases in which E<sup>2</sup>ML documentation is produced; dotted-border boxes indicate phases in which the documentation is exploited.

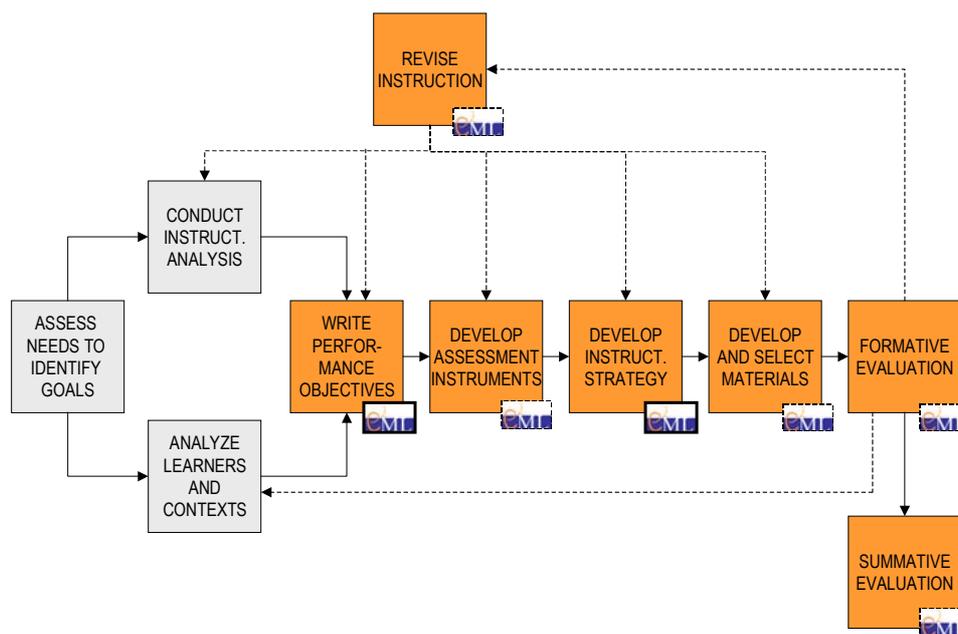


Figure 3.3 - Integration with the Dick, Carey & Carey model

Exception taken for the first phases – the decision to use instruction as a solution to the addressed issues, and the instructional and learners analyses –, E<sup>2</sup>ML supports all phases. The documentation is produced mainly in two moments:

1. *Writing performance objectives*, which may be done using the QUAIL model;
2. During the *develop an instructional strategy* phase: the definition of a learning strategy, and the method for its definition, systematically covers E<sup>2</sup>ML definition of action, as follows:
  - a. *Plan the learning components of the instructional strategy* corresponds to the definition of procedures or the structure of the activity flow, according to the granularity of design.
  - b. *Choose student groupings for learning components* corresponds to determining the acting subject for each action.
  - c. *Select media to deliver learning components* corresponds to the definition of tools and locations (these are also partially defined by the pre-strategy step *select the delivery system*).
  - d. *Assign objective to lessons* corresponds to the assignment of goals to actions and to the structuring of actions into the activity flow.
  - e. *Consolidate media selections* indicates a revision step.

The goal definition would then be a valid support for the creation of test items in the *develop assessment items* phase, while the rest of the documentation would be a support for the development and selection of media and materials, as already explained above.

The whole documentation would finally have an important impact on the evaluation and revision of the instruction. The articulated evaluation process is probably one of the main features of the Dick, Carey & Carey model: it actually provides insight and methods for collecting and analyzing data in order to perform both formative and summative evaluation. E<sup>2</sup>ML enforces such a method by offering a tool that can make the process more systematic. Let's start with formative evaluation. Once data have been collected and analyzed, it is actually up to the designer's instinct and sensibility to decide where to revise the instruction. E<sup>2</sup>ML documentation may serve as tracking system, allowing the designer to move from unachieved goals to related actions, and from the actions to related resources. In other cases, it may provide a support for identifying actions that should be redesigned if a location proved unsuitable to the activity, etc. In short, formative evaluation and revision may find a valid support in E<sup>2</sup>ML documentation.

On the other hand summative evaluation concerns the relationship between the stakeholders (or the client) and the designers: is the instruction valid? Here, the vocation of E<sup>2</sup>ML as an interdisciplinary communication tool may offer a chance of showing the stakeholders how the instruction actually looks like – beyond costs and statistical reports.

### *The Place for Instructional Strategies*

The core of Smith & Ragan's text (1999) is the definition of instructional strategies for different types of learning goals. The relationship between E<sup>2</sup>ML and strategies deserves some lines, as this may also help to shed some light on the delicate articulation between Richards and Rodgers' *approach* and *design* layers (Richards & Rodgers 1982 – see the Introduction).

The QUAIL model obliges designers to express the type of learning goal, thus creating the precondition for an explicit selection of a matching learning strategy. The set of goals defined for a specific subject matter represent an implicit definition of the instructor's or designer's approach. Is Chemistry concerned with concepts or with facts? Is a kind of analytic attitude essential to it? The most straightforward way to answer such questions would probably be defining the goals for a Chemistry course.

Once goals are defined, a strategy is selected, or defined<sup>2</sup>, moving from the layer of *approach* to that of *design*. Strategies are not directly expressed with E<sup>2</sup>ML, as they represent the rationale, the holistic principle of the whole educational environment.

The strategy should then be implemented into the definition of a set of roles and actions, supported by tools and locations, on the layer of *procedure*. A modeling language like E<sup>2</sup>ML may offer a visual representation of a strategy's implementation, and allows the comparison of different implementations of the same strategy. It is likely, and it is an interesting research path, that some regular patterns may be discovered and documented for reuse. Chapter IV will provide some hint in this sense.

Concluding, strategies are not represented directly in E<sup>2</sup>ML, but are the holistic principle for the design of the whole educational environment. They are reflected in the overall structure of the instruction as it appears in the overview diagrams, and may be partially reflected in the definition of single procedures.

### *A Blueprint Language*

The phase in which E<sup>2</sup>ML may be profitably introduced in Greer's model of Instructional Design Project Management (Greer 1992) is the *instructional development*, namely its last four steps, as represented in Figure 3.4.

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<sup>2</sup> The relationship between a set of goals and an instructional strategy is actually one of the most fascinating topics in Instructional Design. It is likely, and it is intuitive, that definite types of goals are better achieved with definite strategies (and this is the hypothesis on which Smith & Ragan's work rests). But what about *a set* of goals of different types? Another issue could be formulated as: "Can all goals (or goal types) be achieved with all strategies? Are there incompatibilities?" If the answer to the first question is *yes*, then the selection of a strategy becomes an economic decision, in which several factors concur: pedagogical effectiveness, learners acceptance, implementation costs, support material availability, time, etc.

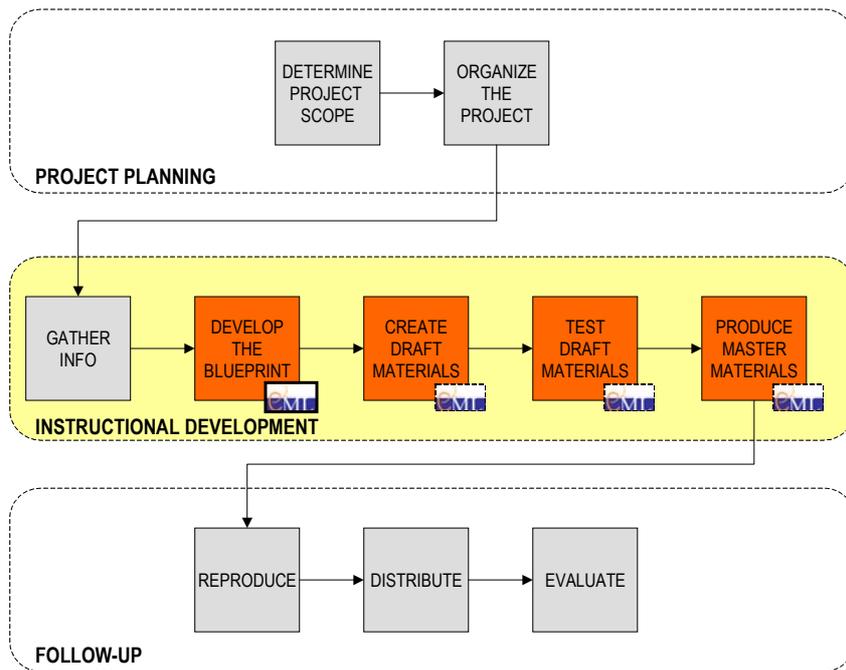


Figure 3.4 - Integration with Greer's model of ID Management

According to Greer's terminology, E<sup>2</sup>ML would be a language for creating the *blueprint* of the instruction, which is the key element for the following phases of material development. The blueprint is a representation of the instruction, and serves both as development documentation and as support for a first approval from the stakeholders.

Using a semi-formal representation language has two main benefits:

1. It compels not to overlook important elements.
2. A visual representation can be used as a communicative device with the stakeholders.

Greer's model, which is highly concerned with resources, constraints and efficiency also gets the benefit of quality control at design time. A complete documentation of the instruction allows checking its consistency and feasibility already during design, anticipating what could be otherwise only performed in the *evaluate* step.

#### *Supporting the "Oval Model"*

As it will be clear from the previous analysis, E<sup>2</sup>ML virtually supports all the nine elements of the Oval Model (Morrison, Ross & Kemp 2003). The arrows in Figure 3.5 indicate which elements provide information to create the documents, and which use the documentation.

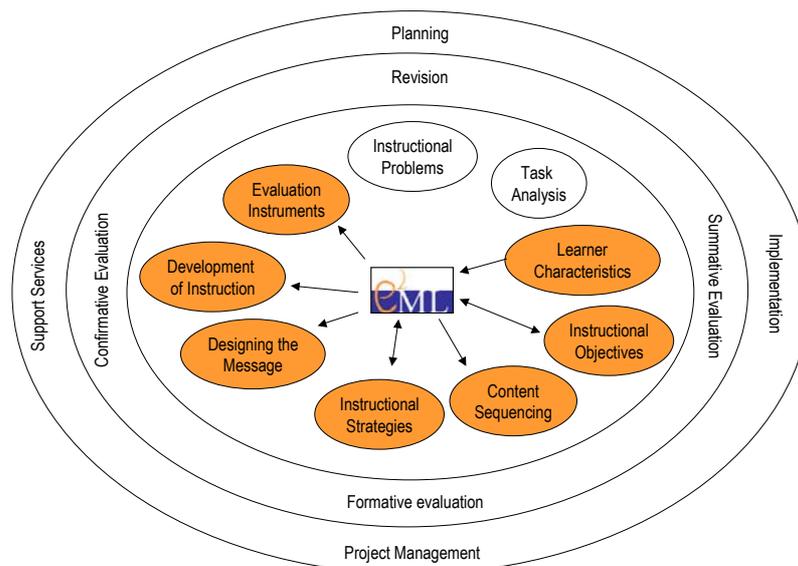


Figure 3.5 - The "oval model" and E<sup>2</sup>ML.

As the content of the nine elements does not differ much from that of other models, further comments will be omitted. Notice that the particular flexibility and practice-orientedness of this model potentially match with the structure E<sup>2</sup>ML and its multiple access points. Namely, understanding the development of instruction as a planned change within an organization, and therefore considering the implementation phase as a delicate communicative and negotiation process, may lead to consider E<sup>2</sup>ML as an interesting communication tool for the design team and for the interaction with the stakeholders.

## Summary

The previous pages have shown how E<sup>2</sup>ML can be profitably integrated, on different levels, with basically any Instructional Design model. This is possible as it is a novel type of tool in Instructional Design: a modeling language. As such, it offers a way of producing documentation that describes the object of design, thus making the design process itself more effective and efficient.

E<sup>2</sup>ML mainly supports the activity of *design*, as it appears in the different models, where the gist of the documentation is produced. The documentation is then exploited basically for two other activities (eventually distributed in several phases): the selection and development of materials, and the evaluation (both formative and summative).

Finally, E<sup>2</sup>ML documentation may serve as communication device with the stakeholders.

## E<sup>2</sup>ML & Learning Technologies Standards

Chapter I introduced the Learning Object trend, the movement at the convergence of education and technologies for the promotion of metadata standards for learning materials.

The definition of Learning Objects is complementary to E<sup>2</sup>ML: while E<sup>2</sup>ML supports the design of an educational environment, Learning Object metadata may enhance the management of tools and learning materials. With respect to the basic specifications of IMS or SCORM, E<sup>2</sup>ML would act as a container describing the structure in which the resources are exploited.

Two recent IMS specifications, also introduced in Chapter I, take a different perspective. One of them is the Reusable Definition of Competencies and Educational Objectives (RDCEO), which describes educational objectives; the other is Learning Design (LD), which describes a whole educational environment in terms of activities. Although the attentive reader will already have noticed that they were developed for completely different goals than E<sup>2</sup>ML, a comparison is deserved in order to assess if QUAIL and E<sup>2</sup>ML are pleonastic once that IMS RDCEO and IMS LD are given, and, if not, what integration is possible.

The following paragraphs tackle the issues first comparing the models, and then claiming that both QUAIL and E<sup>2</sup>ML may play a role of interface between the community of educators and designers and IMS standards.

## QUAIL & IMS RDCEO

The first difference between the QUAIL model and IMS RDCEO is that while the former is a visual tool for representing, discussing and classifying learning goals, the latter is a standard developed “to meet the simple need of referencing and cataloguing a competency or objective, not classifying it” (IMS 2003g, p. 7). This makes a major difference in their use within the design process: while QUAIL can be exploited by designers for achieving a better understanding of goals and for representing them in a shared visual form, RDCEO can be used outside the design process, in either of these two ways:

1. The design team defines the goals, represents them with RDCEO and stores the results in a repository (production).
2. The design team is asked to develop a course for set of standard goals, and look up their definitions in a repository (retrieve).

From a formal point of view, QUAIL is compliant with RDCEO 1.0. The left-hand diagram in Figure 3.6 represents the RDCEO information model. An objective is represented by:

1. An *identifier* (the pair *catalog* and *entry*, as usual in all IMS metadata specifications).
2. A human language *title*.
3. A human language *description* (optional).
4. A more formal *definition* (optional), which is a sort of blank container, “an optional structured description that provides a more complete definition (...) usually using attributes taken from a specific model (...). Typically such models define a competency or educational objective in terms of ‘statement, conditions, criteria’, ‘proficiency, criteria, indicators’, ‘standards, performance indicators, outcome’, ‘abilities, basic skills, content, process’, and similar sets of statements” (IMS 2003g, p.6).
5. Additional metadata.

The *definition* element was included in RDCEO exactly for allowing its extension with other models that would define a specific *vocabulary* for the definition element of RDCEO instances. A definition element is composed by:

1. A *model* attribute: specifies the name of and/or reference to the model (e.g. through an URI).
2. A set of *statements*: each with an *id*, a *name*, and a *text* (if in natural language) or a *token* (if it is an element selected from a list of possible values defined in the model).

QUAIL can be therefore easily represented in RDCEO by specifying the reference to the model and including a suitable set of statements, namely for the *type*, *level*, *scope* and *self-reflective* attributes. Each of the four statements would have a *token* selected among the possible values:

1. Type: fact, concept, procedure, attitude, principle, learning strategy, interpersonal.
2. Level: experience, inquiry, insight, concept, reflection, commitment, action.
3. Scope: remember, use, find.
4. Self-reflective: yes, no.

Complex goals may be represented by including more *type* statements.

The right-hand diagram in Figure 3.6 represents the RDCEO information model extended in with the QUAIL specification.

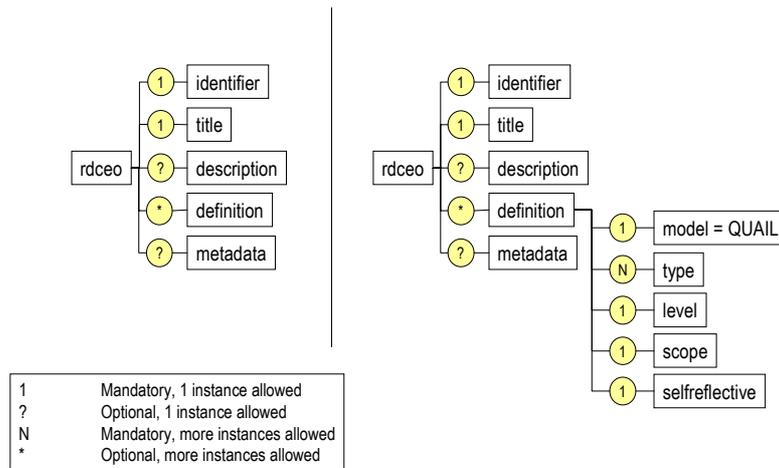


Figure 3.6 - RDCEO and the QUAIL model

Figure 3.7 contains the XML expression of the RDCEO expression of a QUAIL goal (“Be able to define the term ‘logic’ and recognize a formal logic expression”). QUAIL-specific attributes are in bold typeface (please notice that all references are fake).

The formal compliance of QUAIL and RDCEO allows the development of an application that, letting designers work on the definition of learning goals through a visual interface, generates as output the corresponding RDCEO-compliant XML code. On the other hand, a QUAIL visual interface would be able to take QUAIL-compliant RDCEO definitions and display it to an easier understanding of designers and educators. In this sense the QUAIL model may be viewed as an interface between instructional designers and the standard. The development of such applications would indeed bring the standards one step closer to the practice of Instructional Design, and foster the creation of learning goals repositories, as expected by the IMS consortium.

```

<?xml version="1.0" encoding="utf-8">
<rdceo
xsi:schemaLocation="http://www.imsglobal.org/xsd/imsrdceo_rootv1p0
imsrdceo_rootv1p0.xsd http://www.w3.org/XML/1998/namespace
xml.xsd" xmlns="http://www.imsglobal.org/xsd/imsrdceo_rootv1p0"
xmlns:xsi="http://www.imsglobal.org/2001/XMLSchema-instance">

<identifier>
  <catalog>QUAIL example</catalog>
  <entry>1</entry>
</identifier>

<title>
  <langstring xml:lang="en">Logic</langstring>
</title>

<description>
  <langstring xml:lang="en">Be able to define the term 'logic'
and recognize a formal logic expression</langstring>
</description>

<definition>
  <model>http://www.quail.net/definition</model>
  <statement statementid="1" statementname="type">
    <statementtoken>
      <source>http://www.quail.net/voc</source>
      <value>concept</value>
    </statementtoken>
  </statement>
  <statement statementid="2" statementname="level">
    <statementtoken>
      <source> http://www.quail.net/voc</source>
      <value>concept</value>
    </statementtoken>
  </statement>
  <statement statementid="3" statementname="scope">
    <statementtoken>
      <source> http://www.quail.net/voc</source>
      <value>use</value>
    </statementtoken>
  </statement>
  <statement statementid="4" statementname="selfreflective">
    <statementtoken>
      <source> http://www.quail.net/voc</source>
      <value>no</value>
    </statementtoken>
  </statement>
</definition>
</rdceo>

```

Figure 3.7 - Example of RDCEO/QUAIL goal

## E<sup>2</sup>ML & IMS Learning Design

Although the complexity of the specification is surely higher than that of RDCEO, the same relationship exists between LD (IMS 2003a) and E<sup>2</sup>ML. Here as well, the goals for which the two of

them were developed are different: E<sup>2</sup>ML is a visual language for designers, while LD is a formal definition of an educational environment for a compliant platform, thus making the shape of the environment independent from the platform itself, and consequently replicable and reusable. The two models have therefore different potential users: designers and educators for E<sup>2</sup>ML, and technical staff for LD. This is why the stress in LD is on formal features and on the XML binding, while E<sup>2</sup>ML is less formal and basically visual.

The following paragraphs will present a more detailed comparison of the two information models along with a discussion of the critical points and hypotheses for making E<sup>2</sup>ML fully compatible with LD. Notice that in order to evaluate the validity of these remarks the simple introduction of LD proposed in Chapter I is probably not enough. The official IMS specifications are the primary source for further information.

### E<sup>2</sup>ML Information Model

E<sup>2</sup>ML was presented as a set of documents in two versions, in a way familiar and understandable for instructional designers and educators. E<sup>2</sup>ML can be described also using a class diagram, which reveals what IMS would call its information model. This more formal view of E<sup>2</sup>ML is based on the specification given for the Advanced Version, and allows a comparison with the information model of LD.

Figure 3.8 shows the class diagram for E<sup>2</sup>ML. It includes its main classes as they can be extracted by the specification in Chapter II.

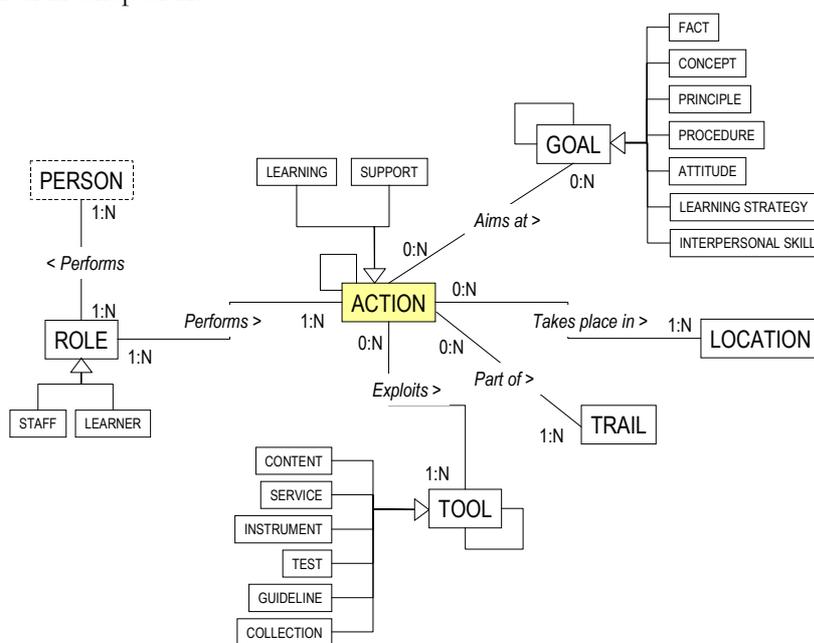


Figure 3.8 - E<sup>2</sup>ML information model (main classes)

The main class is *action*, which can be a *learning action* or a *support action*. Actions are modeled into action diagrams. Actions are conceived in order to achieve *goals*, which can be of different types (the QUAIL model types). The elements in the resource lists are modeled as classes as well. An action is performed by one or more *roles* (“interpreted” by persons – these are actually not modeled in E<sup>2</sup>ML formal notation), which can be *staff* or *learner* roles. The actors can perform actions exploiting one or more *tools*, which can be of different types: *content*, *service*, *instrument*, *test*, *guideline* or *collection*. Finally, an action takes place in one or more (for distributed educational environments) *locations*. Finally, actions can be part of a *trail*, as modeled into the dependencies diagram.

The diagram in Figure 3.8 represents the explicit model of E<sup>2</sup>ML, but other elements of the language require a more sophisticated translation in order to be visible in a class diagram – namely, the flow control devices in the activity flow. With those new elements, the diagram would result as in Figure

3.9 (notice that for improving legibility cardinalities and inheritances have been omitted, along with the *person* class)

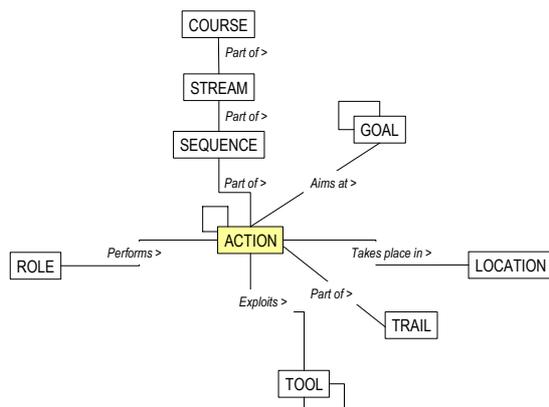


Figure 3.9 - E<sup>2</sup>ML information model (complete)

The activity flow represents a whole *course*, which is composed by more *streams* (parallel sequences of activities), in their turn composed by more *sequences* of actions. This diagram actually provides a synthetic expression of the complete information model of E<sup>2</sup>ML.

#### Information Models Comparison

Although E<sup>2</sup>ML and IMS LD were developed independently, the basic choice of both of them is representing an educational environment as a structured set of activities performed by people with a specific role, supported by resources. The choice was done in both cases for preserving a sort of pedagogical neutrality, so that the models virtually can represent any instructional strategy (IMS 2003a; see and also the discussion about strategies above).

In order to allow a quick comparison, the two information models are reported in Figure 3.10. In order to improve legibility, cardinalities have been omitted, and the *person* classes, present in both models, but not implemented, were removed<sup>3</sup>. Moreover, the LD information model only reports level A, leaving out classes belonging to levels B and C.

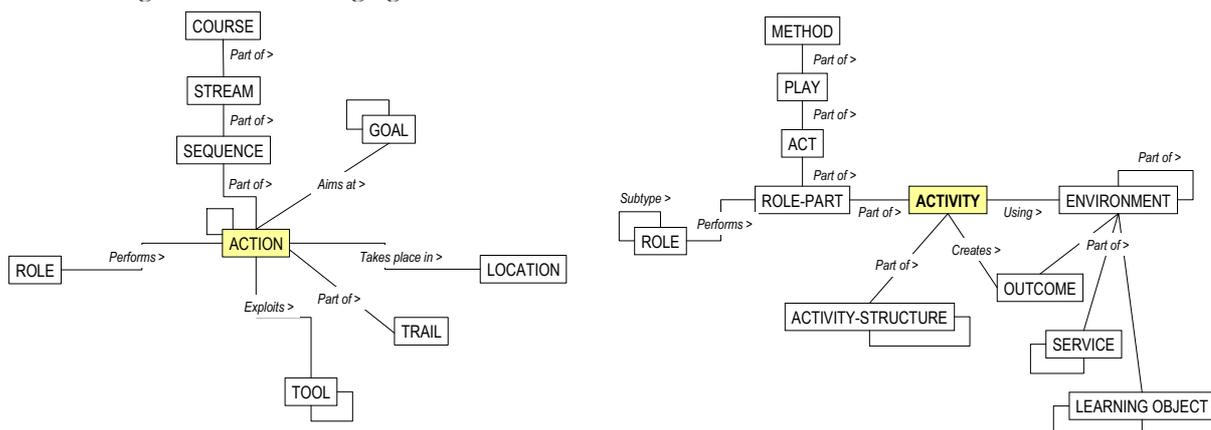


Figure 3.10 – E<sup>2</sup>ML (left) and IMS LD (right) information models

<sup>3</sup> Notice that while LD simply removes the class, leaving the definition of persons to the account and login system of the runtime environment (the platform), E<sup>2</sup>ML keeps track of the names of people assigned to roles in the corresponding resource list.

### Actions & Roles

The idea of both models is that an educational environment is “actors performing actions”. In both models the central class is the *activity*, *action* respectively, and both of them distinguish between *learning* and *support* activities (although the definitions are slightly different, as pointed out in Chapter II).

Nevertheless, due to different requirements for the two models, the implementation of this idea is different. E<sup>2</sup>ML directly assigns the actors with a specific *role* the part of subjects for an action, specifying in the *procedures* what should be actually performed. LD, on the other hand, defines an additional articulation, namely the *role-part* class. It is the lowest element in the *method* hierarchy, a sort of link specifying who (*role*) will do what (performance) in a single *activity*.

The choice of LD is actually more expressive than E<sup>2</sup>ML’s. Defining all elements separately and introducing relationships afterward is a basic principle of object-oriented design that allows more flexibility and easier reuse. The same activity, defined only once, could be implemented with different roles in different environments. According to the definition of *action* in E<sup>2</sup>ML, this would not be possible, as the two actions would be handled with two distinct definitions. The difference directly stems from the different goals of the two languages. The E<sup>2</sup>ML solution was taken in order to improve intuitiveness: designers design instruction instances, where actions are defined according to the roles that will perform them; on the other hand, LD is conceived for representing general definitions of elements that should then be assembled in order to create a real course.

The two solutions are compatible with one another. An E<sup>2</sup>ML specification would be automatically translatable into XML LD descriptors creating *ad hoc* *role-part* classes for each action’s acting subjects. Vice versa, a LD descriptor could be easily translated into the corresponding E<sup>2</sup>ML documentation integrating the information of the *role-part* classes into the definition of *actions*.

### Layered Structure

The general structure of the *method* or *course* is perfectly congruent in the two models, as there is a complete correspondence between *method* and *course*, *stream* and *play*, *sequence* and *act*. The activity flow would then be a possible interface for the generation of the XML expression for such LD classes. Also notice that the conditional statements defined in LD level B correspond to E<sup>2</sup>ML splits.

On the other hand, *trails* are different by nature: these are logical groupings of similar actions, not necessarily bound to the structure and flow of the instruction as such, as it is for *acts* and *plays*.

### Actions & Sub-actions

Another issue is the definition of the internal structure of an activity. While E<sup>2</sup>ML defines the primitive of aggregation (a whole-action may have several part-actions), LD defines a specific *activity structure* class. This latter choice has the clear advantage that in any design *activities* are the minimal unit, and the granularity of activities is set once for all: all other elements are groupings of activities on a different level.

Once more, the difference is due to the different ideas behind the models. The choice of E<sup>2</sup>ML is about usability. It is not in fact easy to discern what is an *activity* and what an *activity structure*, while it is easier to say: “We need more detail for this action, let’s define sub-parts”, without introducing new entities.

The two models are surely compliant on this point: E<sup>2</sup>ML’s aggregations may be translated keeping parts as *activities* and whole-actions as *activity structures*.

### Learning Goals & Prerequisites

Another interesting issue is the place where learning goals are referenced. Goals are not part of the LD specification, which only defines two main references:

1. A reference from the whole *design* to some general goals.
2. A reference from the single activity to “more detailed” goals.

Clearly, the best option for expressing goals in LD would be using IMS RDCEO. The goals in the two kinds of reference are not supposed to be the same ones (even if this would not be forbidden). How should the relationship between the general goals and the detailed goals be interpreted? Are the latter sub-goals of the former? This is clearly different from the general strategy adopted by E<sup>2</sup>ML, which

provides a more fine-grained reference system, allowing all actions to have a specific learning outcome along with a reference to the general goals of the instruction. This issue does not raise any compliance issue: if E<sup>2</sup>ML were transformed into LD, references from actions to goals could be simply deleted.

Another difference concerning goals is the definition of prerequisites to the instruction. LD defines a reference from *method* to the goals that should be considered as prerequisites. E<sup>2</sup>ML does not provide such a system, leaving the definition of prerequisites for the whole instruction undefined (they might be indicated by the PRE goal label). On a different level, E<sup>2</sup>ML allows the indications of action-specific prerequisites and pre-conditions in the initial state definition. It would be easy to extend E<sup>2</sup>ML in order to explicitly expressing prerequisites, e.g. by adding a new *prerequisite statement* table with the same format of the goal statement table; the prerequisites could also be represented with the QUAIL model.

### Abstract Actions

One interesting feature of E<sup>2</sup>ML that is not present in LD is the chance to define *action types*, abstract actions that can be replicated and instantiated into real actions. Notice that according to E<sup>2</sup>ML's definition, *activities* in LD are always abstract (or types) as they should then be somehow instantiated by relationships with *role-parts*.

### Dependencies & Products

Another interesting feature is the definition of dependencies, a core element of E<sup>2</sup>ML, which has no counterpart in LD. Actually, LD defines another primitive that may mimic dependencies, namely conditions (on specification level B). The fact that a single learner could not take Activity B if s/he has not completed Activity A can in fact be interpreted as a dependency. Nevertheless, conditions are at a lower level than dependencies. A learning prerequisite dependency can in fact be translated as a block on an action, but also as a simple warning to the learner, or just as a message to the tutor. Although more practical from a functional point of view, stating conditions does not allow representing a unitary model of pedagogical relationships among actions. Moreover, the definition of dependencies allows postponing the practical decision of how to implement them within the instruction.

Product relationships are explicitly modeled in LD, where *outcomes* (products) are part of the definition of resources (see the following paragraph). Their definition in E<sup>2</sup>ML is implicit, as it is bound to the input/output fields in action diagrams on the one hand, and reprised more evidently in the dependencies diagram on the other.

### Tools & Environments

An important difference, which helps to assess the formal gap between the two models, concerns the definition of resources. LD defines three kinds of learning materials or tools:

1. *Services*: tools that should be re-instantiated in all editions of the instruction, such as a forum (a new forum is needed for all classes that attend the same course).
2. *Outcomes*: all objects produced during some activity and reused afterwards, such as a report. Outcomes were discussed in the previous paragraph.
3. *Learning Objects*: all the rest, from a book, to a Web page, specific software, a CD-Rom, a microscope, etc.

These resources can then be aggregated into *environments*, i.e. collections of resources. This definition perfectly suits the main target situation for IMS, which is full online learning, where collections of digital resources can be created and modified rapidly. Trying to describe a brick-an-mortar situation with the same primitives, leads to paradoxical issues, such as the following: imagine a school where the microscope (a *learning object* – although a weird definition) is on a moving trolley that teachers may reserve and take for experiments in the classes. Now imagine a teacher holding a blended-learning course where experiments are performed together in the lab. For experiment 1, she uses Lab C, which does not include a microscope. She describes all the resources available in it as learning objects in the Lab C environment, and moves on to experiment 2, which will always take place in Lab C, and that requires the microscope. How should she describe the environment? She probably needs to re-

describe all over again and call it Lab-C-with-microscope. Or think of a toolbox for woodwork: it is a collection of tools, but would you call that environment?

E<sup>2</sup>ML reprises and enriches some of these distinctions in order to allow the description of a wider range of situations, including face-to-face interactions. E<sup>2</sup>ML defines in fact the *tool* class, which gathers resources of different types:

1. Content: corresponds to *learning objects* offering some content (information, concept definitions, explanations, etc.).
2. Service: exactly corresponds to LD *services*.
3. Instrument: describes tools enabling specific activities (the screw, the microscope, the TV set, etc.).
4. Test: includes exercises, self-assessment tools, etc.
5. Guideline: describes all materials that provide a description or any form of guidance for activities (e.g. an activity description).
6. Collection: describes a collection of tools (such as the woodwork toolbox), and would be transformed into an *environment* in LD.

Notice that *content*, *instrument*, *test* and *guidelines* tools would all be labeled as *learning objects* in LD.

The definitions of tool classes should be used together with that of *locations*, which describe where activities may take place. This is a great advantage of E<sup>2</sup>ML, as even in a completely online education program learners and instructors are in a physical location where they can at least access the network. The importance of a suitable location with the necessary facilities is paramount, and will not be discussed here. The microscope in our example would then be a *tool-instrument*, transported to a location for a specific activity. If it were fixed in Lab C, it would be a *facility* of that location.

The difference about tools is relatively big, and due to the understanding of learning objects as digital entities proper of IMS<sup>4</sup>. The richer description of E<sup>2</sup>ML could be easily translated into LD by leaving locations out, and describing all content, instrument, guideline and test *tools* as *learning objects*, and *collections* as (sic) *environments*.

#### *Action and Activity*

The definitions of the main classes in the two information models deserve some attention. The different requirements for which the two models were developed produced once again in different descriptions.

Table 3.1 shows the attributes of LD *activity* class on the left and of E<sup>2</sup>ML *action* class on the right. Attributes on the same row are equivalent, while asymmetries are marked with a hyphen. Attributed containing references are reported in italics.

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<sup>4</sup> While this definition can hold for Learning Objects, it is difficult to think of a complete educational environment (the proper target for Learning Design) as completely digital. A course can in fact exploit digital and non digital resources, but an educational environment will always include physical components, as learners are in any case people, who stay somewhere and use real-world tools. The definition of tool categories is where the limitation intrinsic in the “only digital” perspective best shows its drawbacks.

Learning Design	E <sup>2</sup> ML
Title	Name + tag
Type	Type
(Role-parts classes)	Roles
Learning Objectives	Expected outcome
Pre-requisites	Prerequisites
-	Pre-conditions
-	Side-effect
Activity description	Procedure
-	Duration
Environment ref	Input
	Tools
-	Locations
(Outcomes)	Output
Complete-activity	-
On completion	-
Metadata	-
-	Goal reference

Table 3.1- Activity and action definitions

Table 3.1 clearly shows the differences in the two definitions. E<sup>2</sup>ML is more fine-grained in describing the initial and final states of the action, thus including *pre-conditions* and *side effects* (*input* and *output* are implicitly covered by *environment* in LD). E<sup>2</sup>ML pays great attention to face-to-face instruction, as stressed by the presence of the *duration* and *location* attributes.

On the other hand, LD shows here its perfect tailoring to online learning, including in the definition three attributes which are counter-intuitive for educators but technically necessary for the runtime environment: *complete activity*, which expresses the conditions for the completion of an activity (a report is submitted, at least three hours have gone by, etc.); *on completion*, which describes the action to be performed once that the action is completed (an automatic action, when no human instructor is leading), and *metadata*, which provides references to further descriptors.

This is the point on which the greatest effort would be required in order for making E<sup>2</sup>ML fully LD-compliant without making it too detailed and clumsy for the actual instructional design practice.

### *An Interface?*

Before drawing a synthetic conclusion, it is worthwhile to recall that the two models refer to different situations and have different requirements. E<sup>2</sup>ML describes in fact a single instruction, online, face-to-face or blended mode, and this explains its attention to locations, people, tools and durations. On the other hand, LD describes a general schema of instruction, which can be then implemented by giving the description as input to a compliant platform. This requires the specification of descriptors for the runtime environment, and explains the particular suitability of this model for electronic resources. The comparison was therefore performed in order to see if integration is possible and how, and not to assess the relative advantages of either of them.

From a practical point of view, E<sup>2</sup>ML rests on the assumption that most designers are likely to prefer using visuals than XML code for design. This is why E<sup>2</sup>ML was kept as simple and understandable as possible, especially in the Core Version. Moreover, it is also likely that those who would like to use metadata would benefit from a visual interface. E<sup>2</sup>ML could be therefore extended in order to completely match the specification of LD.

Under this perspective, the results of the comparison can be summarized in the following points:

1. Generally speaking, the information models do not present great gaps in terms of class structure. A complete compliance could be defined with little further work starting from the current E<sup>2</sup>ML specification.
2. In any case, compliance is currently possible only for level A (mandatory elements for compliance), as no information about runtime behavior is included in E<sup>2</sup>ML. Its inclusion would be a specific task for the integration.
3. Other extensions would include as main elements:

- a. Explicit prerequisites definition (in terms of learning goals).
  - b. The implementation of level B and C.
4. Some information is richer in E<sup>2</sup>ML than it is in LD. It should be (automatically) compressed in order to translate the former in the latter. Specific issues on this point are:
  - a. Mapping tool classes on LD primitives (learning object, environment, service).
  - b. Mapping the initial and final states of actions on LD primitives (prerequisites, goals).
  - c. Mapping locations as environments.
5. The description of face-to-face instruction (or parts of instruction) would probably need an extension of LD.

The hypothesis to be considered is that automatic parsing could support the translation from E<sup>2</sup>ML to LD. If this proves to be true, the following functional integration of the two models would be possible:

- Extended E<sup>2</sup>ML could be used as a visual interface for reading LD XML code.
- Extended E<sup>2</sup>ML could be the conceptual framework for a visual authoring interface for LD<sup>5</sup>.

## E<sup>2</sup>ML & Other Representation Languages

Before leaving definitely place to the case studies, E<sup>2</sup>ML should be compared to other representation languages. The focus is on two of them, the former coming from the field of education, and the latter from Process Design.

### T5 Model of Instructional Activities

Although the T5 model (LT3 2003) was developed as a support model for Instructional Design, it is by no means a classic model as the ones presented in Chapter I. It is nearer to a language, as E<sup>2</sup>ML, as it provides a standard way of representing an instructional activity.

T5 was developed for “scaffolding the transition from concept to design” by the instructors – namely faculties in Higher Education – and is therefore tailored to non-professional designers. T5 has a much narrower scope than E<sup>2</sup>ML, and it focuses on the activities in order to enhance the integration of learning objects.

T5 is a contracted acronym for five elements that describe an instructional activity, namely:

1. Task, or goals.
2. Topics being covered.
3. Tools being exploited.
4. Tutoring being provided by the teaching staff.
5. Teamwork or interactions among peers.

The T5 model was proposed as backbone of a metadata representation for educational activity, the role actually covered by IMS LD.

This pattern of representation of an activity is matching with E<sup>2</sup>ML actions. Notice that *topics*, *tutoring* and *teamwork* are not explicit in action diagrams, but are included in the *procedure* description.

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<sup>5</sup> An explorative project was started with such hypotheses at the Università della Svizzera italiana, developing an E<sup>2</sup>ML add-in for Rational Rose. The work is reported in (Saluzzi 2002 – see Appendix E for further details).

## Flow Control for Education

E<sup>2</sup>ML is basically an education-specific process management language. This is particularly evident in overview diagrams, whose formalisms belong to that discipline. While the definition of the CBS and the dependencies diagram are relatively plain, the activity flow is formally more complex, and should be framed in the context of workflow management. This section is therefore devoted to its formal comparison with standard modeling patterns in control flows. This might be useful both in order to provide a framework for the definition of further extensions of E<sup>2</sup>ML and to assess the requirements for an eventual workflow engine to support E<sup>2</sup>ML.

As in the previous section, it is worthwhile to recall that the comparison is merely formal, and that it aims to a possible integration rather than to a comparative evaluation. The activity flow is in fact a tool for fostering creative thinking and improving design, while formal workflow control is used to control (automatic) processing. This is the reason why the degree of formality and expressiveness are uneven – like their intuitiveness and usability.

### *The Definition of Activities*

The first relevant feature of E<sup>2</sup>ML as a process management language is the peculiar definition of activities, which is strictly bound to the necessities of educations. This is evident in the classification of resources (locations, tools), the definition of roles, the description of the initial and final states (prerequisites/learning outcomes, pre-conditions/side-effects, input/output) and the relationship to learning goals.

### *Flow Control Devices*

The activity flow presents several devices that allow the representation of parallel activities, choices, conditions, etc. E<sup>2</sup>ML introduces them with original names, more related to the specific instructional context, but they are actually comparable with more general definitions. Moreover, Flow Control defines a number of other devices that are currently not included into the E<sup>2</sup>ML specification.

Table 3.2 (taken from PATTERN 2003) lists standard flow control pattern, along with a short description. The last column indicates if there is an equivalent expression in the E<sup>2</sup>ML specification. When no direct E<sup>2</sup>ML counterpart for the pattern is indicated, the notation is the following:

- *EXT* means that the pattern is not currently covered but it would be a useful extension.
- “-“ means that the pattern it is not currently covered and that it does not seem to have a strong relevance for representing instruction or in the specific design context.

The complete formal definitions of the devices along with their properties can be found in (Kiepuszewsky, ter Hofstede & van der Aalst 2002).

PATTERN	EXPLANATION	E <sup>2</sup> ML MAPPING
Sequence	Sequential flow through activities	Sequence
Parallel Split (AND-split)	Location in the flow where from one branch start more branches that must be all executed	Parallel activities (ALL)
Synchronization (AND-join)	Location in the flow where more branches converge and the following action takes place only when all incoming branches are terminated	Join (implicit)
Exclusive Choice (XOR-split)	Location in the flow where from one branch start more branches of which only one must be executed	Option (SELECT)
Multi Choice (N-out-of-M-split)	Location in the flow where from one branch start more branches of which only a definite number must be executed	Selection (AT LEAST X)
Synchronizing Merge	Location in the flow where more branches converge and the following action takes place when each incoming branch is terminated (i.e. once for each branch)	EXT
Multi merge	Location in the flow where more branches converge and the following action takes place only when N incoming branches are terminated	EXT
Discriminator	Location in the flow where more branches converge and the following action takes place only when the first incoming branch is terminated (i.e. only once)	EXT
Arbitrary Cycles	A cycle that can be started and terminated at any point (i.e. no initial and final actions are defined)	EXT
Implicit Termination	The flow is terminated when no action must be executed (different from deadlock)	-
Multiple instances without synchronization	An action can be instantiated several times.	EXT
Multiple Instances with a priori Design Time Knowledge	An action can be instantiated several times, and the number of times is known at design time.	Repeat the action N times
Multiple Instances with a priori Runtime Knowledge	An action can be instantiated several times, and the number of times is known at a definite moment during the flow.	EXT
Multiple Instances without a priori Runtime Knowledge	An action can be instantiated several times, and the number of times is not known at any moment.	EXT
Deferred Choice	An XOR-split where the decision about what branch to take is not bound to the evaluation of a condition: all branches are set to READY, and then only one is activated (de-activating the other)	-
Interleaved Parallel Routing	A location in a flow where a set of actions can be executed in any sequence	Any-order box
Milestone	A location in the flow where a decision is taken evaluating a status (not a variable)	EXT

Table 3.2 - Flow control devices

Without coming to the utmost detail, which would require a greater space than the available, the first important remark is that E<sup>2</sup>ML actually covers a great part of the standard flow control patterns. For a comparison list of other flow control languages see (PATTERN 2003).

What are basically missing are cycles, multiple instances handling and the distinction of different types of join. These features require in fact a high level of abstraction, and would probably make the activity flow too complex rather than more expressive.

Another interesting feature that is not currently modeled by E<sup>2</sup>ML is the *milestone* pattern: E<sup>2</sup>ML does not represent states to which learners come to at different stages in the instruction. All the same, this would be useful for a more fine-grained description of the environments, which could state things like “if the learner has submitted the report” or “if the group has undergone at least three revisions”, etc.

A last remark concerns the style of notation adopted. E<sup>2</sup>ML uses mainly UML-like notation, while the activity flow follows a different set of rules. An interesting contribution to fill the (apparent) gap between the two notations is proposed in (Dumas & ter Hofstede 2001).

## Summary

E<sup>2</sup>ML is a visual language that gets inspiration, insights and formal elements from a set of other disciplines. This Chapter provided its proper interdisciplinary framework in order to allow the recognition of its roots and to foster scientific cross-disciplinary discussion. The requirements for which E<sup>2</sup>ML was developed were recalled several times, in order to explain the points in which it is different from other models and languages, and to assess its proper focus and value.

The first step explored E<sup>2</sup>ML from within, reviewing its structure, its sources, and indicating its potential use contexts.

The analysis then moved to the more natural context for E<sup>2</sup>ML, Instructional Design models. The issue was considered from a mostly practical point of view, asking “Can E<sup>2</sup>ML be successfully integrated into the designer’s work? How?”

The third section concerned technical standards for educational environments, and proposed a double formal comparison between:

1. QUAIL and IMS RDCEO, with the claim that QUAIL categories can be incorporated into RDCEO as a vocabulary extension;
2. E<sup>2</sup>ML and IMS LD, whose integration would require extensions of the former in order to make it compliant with the latter.

The general hypothesis is that E<sup>2</sup>ML could provide the framework for a conceptual and applicative interface between these IMS standards and the current practice of instructional design.

Finally, a brief focus on T5 and on flow control languages allowed the definition of what formal devices E<sup>2</sup>ML supports at a conceptual level. This allows the identification of possible extensions.

After these pages E<sup>2</sup>ML can be recognized as a new tree rooted in a long tradition, nurtured by several elements coming from different fields. Any further development of E<sup>2</sup>ML, as any attempt to define a similar language, should consider these roots and keep alive the dialogue with other disciplines.



## CHAPTER IV

### CASE STUDIES

*"Of course I'll gladly give de rule  
I meks beat biscuits by  
Dough I ain't sure dat you will mek  
Dat bread de same as I*

*'Case cookin's like religion is –  
some's elected an' some ain't  
An' rules don't know more mek a cook  
Den sermons mek a saint"*

*(Howard Weeden, from Bandanna Ballads, 1899)*

After a presentation of the state of the art in Instructional Design in Chapter I, and the definition of E<sup>2</sup>ML and its discussion in Chapters II and III, Chapter IV presents some case studies. The goal of this Chapter is therefore to show in practice the use, benefits and limitations of E<sup>2</sup>ML and QUAIL, and at the same time to provide a chance to get acquainted and familiar with their expressive devices. The first sections present the design of five courses in Higher Education institutions; these are properly labeled *case studies* in the following pages. While the first case study will focus on the formal expression of specific features, the others will focus on the integration of E<sup>2</sup>ML in the design process. The last section explores the possibility of expressing pedagogical patterns with E<sup>2</sup>ML.

Observed in the different contexts of the case studies, E<sup>2</sup>ML proves to be equally effective to different topics, instructional scenarios and design processes; but most of all, the language reveals a great flexibility in representing different delivery modes (face-to-face, online and blended learning): the presence of technologies generates the need for a more structured design language, but their absence is not a hurdle to its use at all.

Given the limited space, the case studies focus on E<sup>2</sup>ML documentation. The description of the instructional strategy, of the technologies and of the design process itself is condensed in a short description of the issues at stake and in some notes about the outcomes of the basic design phases (needs assessment, learning analysis, task analysis, objectives definition, design, development, evaluation). The complete E<sup>2</sup>ML documentation for each case study is provided and discussed, in the light of its actual use, and specific points of interest are highlighted.

Case studies exploit both the Core and Advanced versions. They will provide guidelines for understanding what situations best suit each of them. The definition of pedagogical patterns only uses the Core Version.

In order to provide orientation through the case studies, Table 4.0.1 provides some indication about the content of each of them. The same attributes are reported at the beginning of each case study along with an abstract.

CASE STUDY	INSITUATION	E <sup>2</sup> ML VERSION	DELIVERY TYPE	FOCUS
ETEC 512	UBC, Vancouver (CA) & TEC Monterrey (MX)	Core	Completely online	Block-unit structure, case-based discussions
ISTITUZIONI 3	USI, Lugano (CH)	Core	Blended learning	Course without standard week class, online + class
ISTITUZIONI 1	USI, Lugano (CH)	Advanced	Face-to-face	Classic classroom-based course
TELEINFORMATICA 1	UNIVELS, Milano (IT) & Eurocol, Bogotá (CO)	Advanced	Completely online	Videoconference-based course, lectures + atelier
LOGICA	USI, Lugano (CH)	Advanced	Face-to-face	Integration weekly class + group activity

Table 4.0.1 - Case studies overview

The profiles of the institutions in which the courses were designed are provided in Appendix D. The development of case studies and patterns involved a number of people, whose support was essential for the growth of this work. Their names are reported in the acknowledgments.

## ETEC 512 @ DE&T, UBC, Vancouver

<b>Institution</b>	UBC (Canada) in collaboration with Monterrey Tec (Mexico)
<b>Design situation</b>	Post-design modeling in a Master program in Distance Education
<b>Topic</b>	Learning Theories
<b>Delivery type</b>	Completely online
<b>E<sup>2</sup>ML version</b>	Core
<b>Role of E<sup>2</sup>ML</b>	Thinking tool
<b>Abstract</b>	E <sup>2</sup> ML was used in the development of this online course only as a tool for thinking and not during the whole design process.

This first short case study is different from the following ones as its goal is to let the reader get acquainted with E<sup>2</sup>ML diagrams. E<sup>2</sup>ML was not used for the design, if not as inspiration for some choices, and the presentation of the case is consequently abstracted from the design process.

### The Course

The course *EETEC 512 – Learning Theories* is part of the online master program offered by Monterrey Tec in collaboration with Distance Education & Technology (DE&T) at the University of British Columbia (UBC). Its goal is to provide “an examination of some of the prominent conceptual models of learning, along with experience in the practical application of selected models to using Instructional Design” (from the course development blueprint). The course strategy is to foster the connection of learning theories with Instructional Design through the analysis of case studies.

EETEC 512 is delivered completely online, supported by WebCT, to 30-50 participants from potentially all over the world. It is a classical asynchronous online course: materials are available online to the students, who are supposed to use them according to a predefined calendar structured in blocks, each containing one or more units.

The calendar also includes periods of online discussion between the students in groups and with the instructors, supported by a forum. Contact with the instructor can as well happen via telephone, if a student requires it. Finally, personal written assignments are used for the evaluation, along with an assessment of the overall participation.

### Design

#### *Design Structure*

The course was structured in four blocks and eight units (each block has a different number of units) according to the topics to be covered. Each unit includes as basic structure the presentation of some materials, a case-based discussion and a conclusion. Each block is concluded by a graded personal assignment that wraps-up the content of the units.

The topics of the blocks and units are the following:

- Block 1: Teaching Perspectives.
  - Unit 1: Epistemology and Learning.
- Block 2: The Individual Learner.
  - Unit 2: From Programmed Instruction to Distance Education: Behaviorist Approaches.
  - Unit 3: Development and Maturation.
  - Unit 4 Neuroscience and Learning.
  - Unit 5: Cognitivism.
- Block 3: Constructivism and Context.
  - Unit 6. Cognitive Constructivism.
  - Unit 7. Social Constructivism.
- Block 4: Motivation.

- Unit 8: Can I do it? Do I want to do it? (Theoretical constructs related to students' self-perception of ability; theoretical constructs related to students' needs to achieve).

A short course introduction was set up for introducing students to the topics and to the method used for distance learning.

### *The Design Process*

Four authors worked together for the development of the course (two from Monterrey Tec and two from UBC), and each of them was in charge of a different set of units. An instructional developer from DE&T coordinated the process.

### *Role of E<sup>2</sup>ML*

E<sup>2</sup>ML was used for sketching some possible solutions in order to analyze them, but was not thoroughly used in the project.

## **Goal Definition**

A first interesting element from ETEC 512 is the formalization of goals, which started from the following statement by the course authors:

By the end of this course students will be able to:					
A.	Describe selected epistemologies of learning and relate them to the teaching - learning process.				
B.	Discuss major orientations leading to significant learning theories influencing instructional design theory.				
C.	Critically examine selected major theories of learning and will learn to recognize and to apply them in instructional situations using learning technologies.				
D.	Use one or more theories of learning as a lens to describe, discuss, and analyze teaching and learning situations using learning technologies.				
E.	Use one or more theories of learning to solve given instructional design problems or approved design problems arising from the students' own situations.				
F.	Explain own initial philosophy of / conceptions of teaching and learning				

Figure 4.1.1 - Initial goal statement for ETEC 512

In order to refine the goals, let's point out that:

1. Statement A groups two different goals: describe and relate.
2. Statement C mixes a number of different issues: analyze theories, understand them, recognize them, etc.
3. In particular, "recognize a theory in an instructional situation" in statement C overlaps with statement D (analyze an instructional situation).

Goals were therefore refined as in the following E<sup>2</sup>ML goal statement table (Table 4.1.1).

### *Goal Statement*

GOAL STATEMENT					
TAG	STATEMENT	TARGET	STAKEHOLDER	ASSESSMENT	IMP.
A	A1: Describe selected epistemologies of learning A2: Relate them to the teaching learning process	All students	Development team	TBA	5
B	Discuss major orientations leading to significant learning theories influencing instructional design theory.	All students	Development team	TBA	4

C	Critically examine selected major theories of learning C1: Understand them C2: Evaluate them	All students	Development team	TBA	5
D	Use one or more theories of learning as a lens to describe, discuss, and analyze teaching and learning situations using learning technologies.	All students	Development team	TBA	5
E	Use one or more theories of learning to solve given instructional design problems or approved design problems arising from the students' own situations.	All students	Development team	TBA	5
F	Explain own initial philosophy of / conceptions of teaching and learning	All students	Development team	TBA	4

Table 4.1.1- ETEC 512 Goal statement

Notice that assignments are not defined in this table (they were defined later in the design process).

### Goal Mapping

The goal mapping with the QUAIL model clearly shows its expressive power, catching the distinctions between the different goals (Figure 4.1.2).

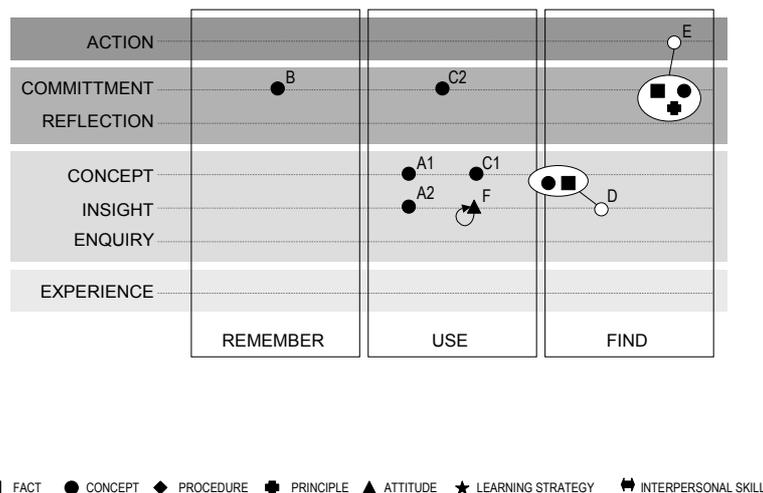


Figure 4.1.2 – ETEC 512: goal mapping

In order to improve familiarity with the QUAIL model, the detailed analysis of each goal is reported in below:

- A1 and C1 are *concepts* (epistemologies and theories of learning) on the *concept* level, as students are asked to know them explicitly. The scope is *use*, as they should be connected to real situations
- A2 also deals with *concepts* as A1, but on the *insight* level, where concepts are to be used (the scope is *use*) for enlightening situations.
- B describes *concepts* that are simply to be *remembered* (major orientations), but they are on the *commitment* level as students are pushed to a critical review of them.
- C2 also addresses *concepts* (learning theories) but also includes a critical effort and is therefore on the *commitment* level. Its scope is *use* as this judgment will influence the design.
- D is a complex goal, including *concepts* and *facts*, and is in the *find* scope, as it deals with the analysis of new situations. The level is that of *insight*, as it deals with the understanding of instance situations.

- E is a goal similar to D, but also includes design *principles*. It is also in the *find* scope, but on the *action* level, as the learner’s design ability is here at stake.
- F finally has an *attitude* as knowledge object – namely, the learner’s own attitude toward teaching and learning. This is why it is a self-reflective goal. It is on the *insight* level (each learner is concerned with her/his own attitude), and in the *use* scope, as this understanding should be applied in constantly observing one’s own activity. This goal could have been actually also placed in the find scope, implying that once one is aware of her/his conception, s/he can work on it and extend it.

## Overview Diagrams

### *Dependencies Diagram*

The dependency diagram was developed at block level, as represented in Figure 4.1.3.

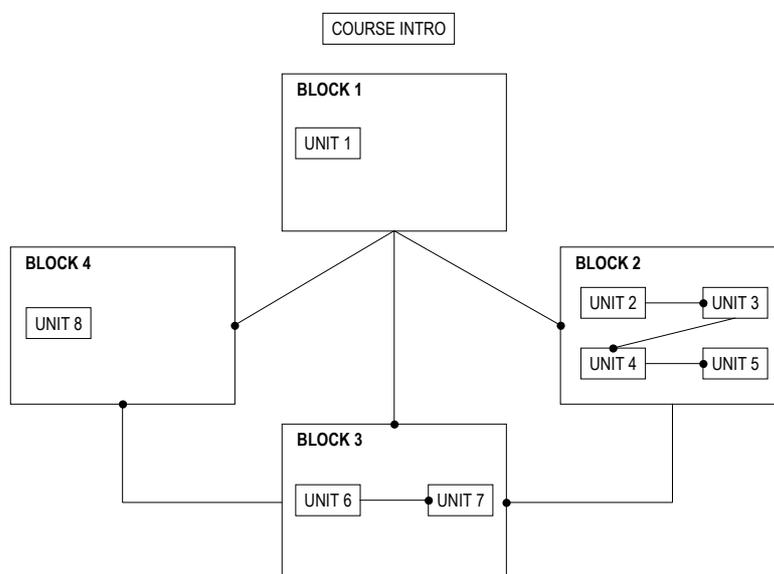


Figure 4.1.3 – ETEC 512: dependencies diagram (blocks)

Along with the sequential nature of the course, which follows the historical development of learning theories, the dependencies diagram shows the centrality of UNIT 1, a small unit that aims at developing in the learners the awareness of their personal approach to education and teaching. This achievement (corresponding to goal F) serves as basis for the rest of the course. Moreover, all instructors teaching other blocks will have to know the results of UNIT 1.

The further development of the dependencies diagram was on the unit level. The complete example for a single unit is enough for the purposes of this case study. The details of UNIT 2 can be observed in Figure 4.1.4. The unit is composed by introduction, discussion and analysis. The results of the analysis are then reviewed by the instructor, which then provides a conclusion to the work on the discussion forum. The details of the actions are provided in the action diagrams in Figure 4.1.5.

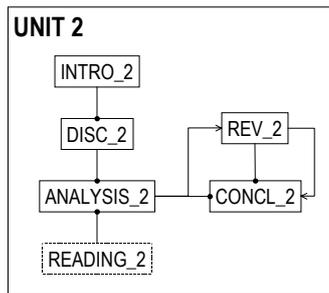


Figure 4.1.4 - ETEC 512: dependencies diagram (unit2)

Introduction to UNIT 2		INTRO_2
S		LEARNING
-	Know what behaviorism is, know an example of behaviorist design	B C1 D
Use the Web	-	
-	Notes of discussion	
STUDENT: go online, read the presentation of behaviorism. Read the case study and work on the basis of questions. Prepare questions and comments for the discussion. DUR: 4h		
Anywhere		
WS, Case2		

Assignment for UNIT 2		ASSIG_2
S (in groups)		LEARNING
Concept and evaluation of behaviorism	Critical understanding of behaviorism (limits / potentialities)	B C1 C2
Use the Web	-	E
-	Lesson plan + comments	F
PROJECT: given the assignment, work with your group in order to solve it (Assignment is a description of a design problem to be solved applying behaviorist principles. It then asks to evaluate and critically revise the work according to the group members' view on education). Submit the lesson plan. DUR: 6h over 1 week		
Anywhere		
WS, FORUM, ASS2, SUBMIT		

Discussion for UNIT 2		DISC_2
I, S		LEARNING
Concept of behaviorism; knowledge of the case study for UNIT 2	Critical understanding of behaviorism (limits / potentialities)	B C1 C2
Use the Web	-	D
Notes for discussion (from INTRO_2)	Forum postings	
ONLINE FORUM DISCUSSION DUR: 2h over 1 week		
Anywhere		
WS, FORUM, Case 2		

Revision for UNIT 2		DISC_2
I		SUPPORT
-	-	
Use the Web	-	
Assignment 2 submissions	Notes	
Revise the submissions and prepare comments and remarks for the conclusion DUR: 8h		
Anywhere		
WS, SUBMIT, ASS2		

Conclusion for UNIT 2		CONCL_2
I, S		LEARNING
Revised and evaluated concept of behaviorism;	Critically revised application of behaviorism	B C1 C2
Use the Web	-	E
Assignments + Instructor's notes	Chat log	F
CHAT DISCUSSION DUR: 2h over 1 week		
Anywhere		
WS, CHAT		

Figure 4.1.5 - ETEC 512: action diagrams (unit 2)

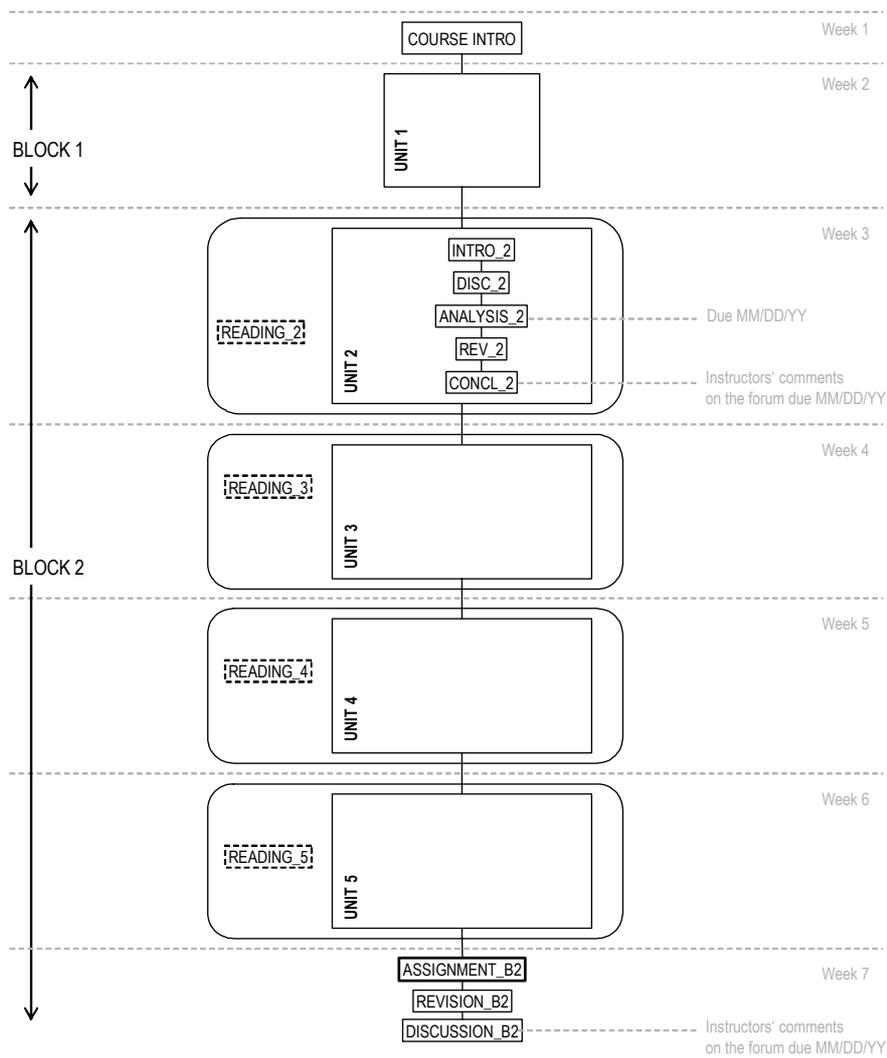
Notice that all actions may take place anywhere, and all of them exploit the course Web site, powered by WebCT, which contains the forum and the documentation for the cases.

### Activity Flow

The activity flow (Figure 4.1.6) is quite simple, but deserves some remarks that can improve familiarity with E<sup>2</sup>ML notation.

Except for the course introduction and for UNIT 1, all units are represented as the contemporary execution of a main body (labeled with the unit number) and some optional readings. The body of each unit is then composed by different sub-actions, here indicated only for UNIT 2. Assignments are placed at the end of BLOCK 2 (notice that the diagram reports only the first half of the course).

Week lines are used as main temporal reference on the diagram, while specific dates are indicated for checkpoints and submissions (notice that the dates are here blinded).



[To be completed with UNITS 6 to 10]

Figure 4.1.6 – ETEC 512: activity flow

### Possible Solutions for UNIT 5

A particular use of E<sup>2</sup>ML for ETEC 512 was the development of four alternative solutions for UNIT 5 (cognitivism). The basic structure of the unit remains the same: content introduction, discussion and assignment, yet every version has its own specific features. The basic idea was to have the students working on an example of online course developed with a cognitivist approach (namely, the WOOD 120 course at UBC). Figures 4.1.7 to 4.1.10 show activity flow and dependencies diagram for each alternative version.

- Version A foresees groups, and has a theoretical introduction in the beginning of the unit with READING 1, and then a second reading to support the case before the group discussion (READING 2). The idea here is that a first theoretical introduction may provide a wider horizon

than if starting directly with the case. A final discussion of the whole class concludes the analysis work before the assignment.

- Version B also foresees groups, but first sets the case scenario and only afterwards introduces theoretical readings. This has the benefit that any theoretical content would be directly referenced to the practical case. On the other hand, issues not directly bound to the case are likely to slip away.
- Version C is conceived for single learners, so that the only discussion is the concluding one. The readings structure is the same as Version A.
- Version D has the same structure of Version A except that the final discussion comes after the assignment (differently from all other versions). This could be sensible as students are then expected to have a more definite understanding of the content for the discussion. On the other hand, the benefit of the final discussion will not be reflected in the assignment.

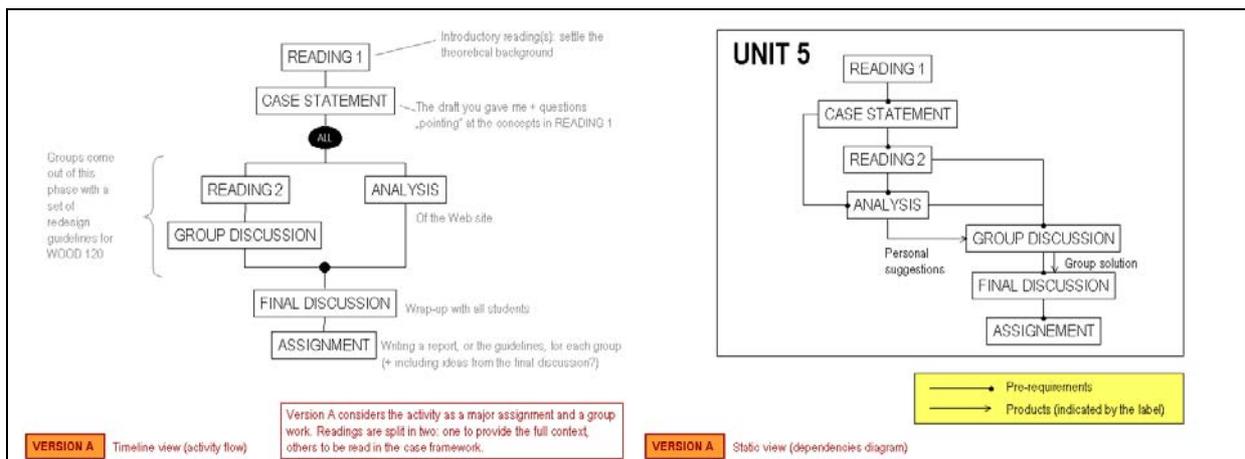


Figure 4.1.7 - UNIT 5, version A

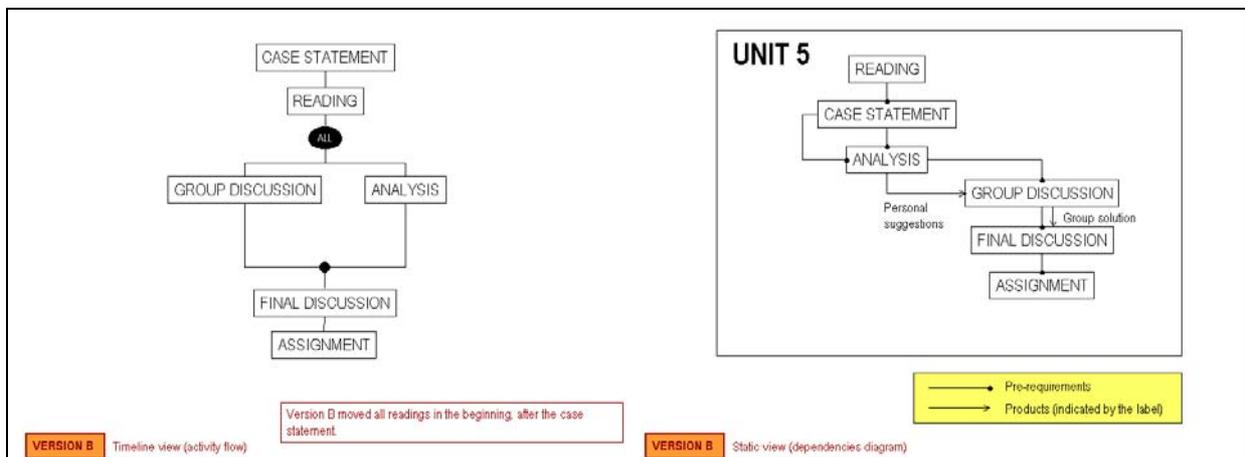


Figure 4.1.8 - UNIT 5, version B

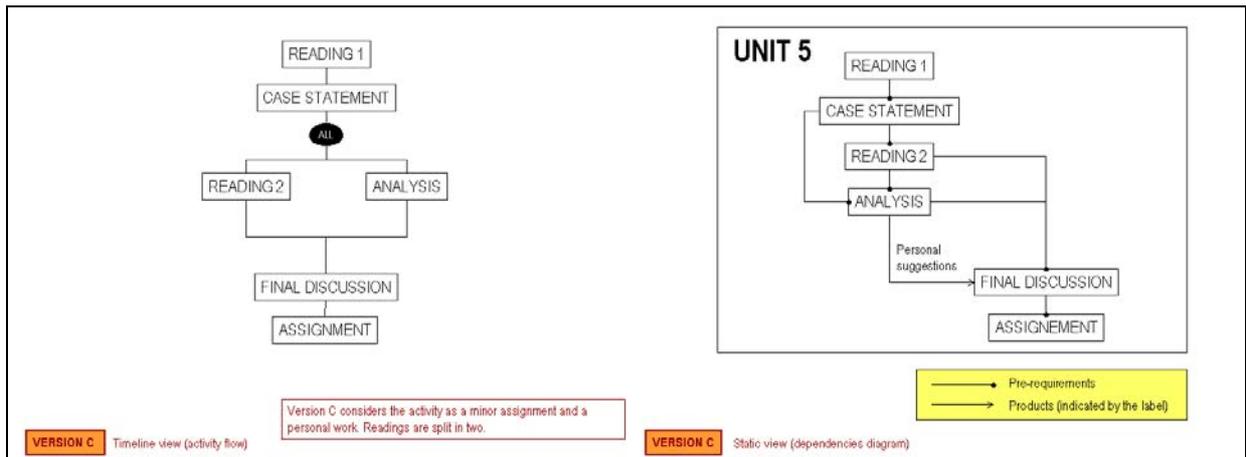


Figure 4.1.9 - UNIT 5, version C

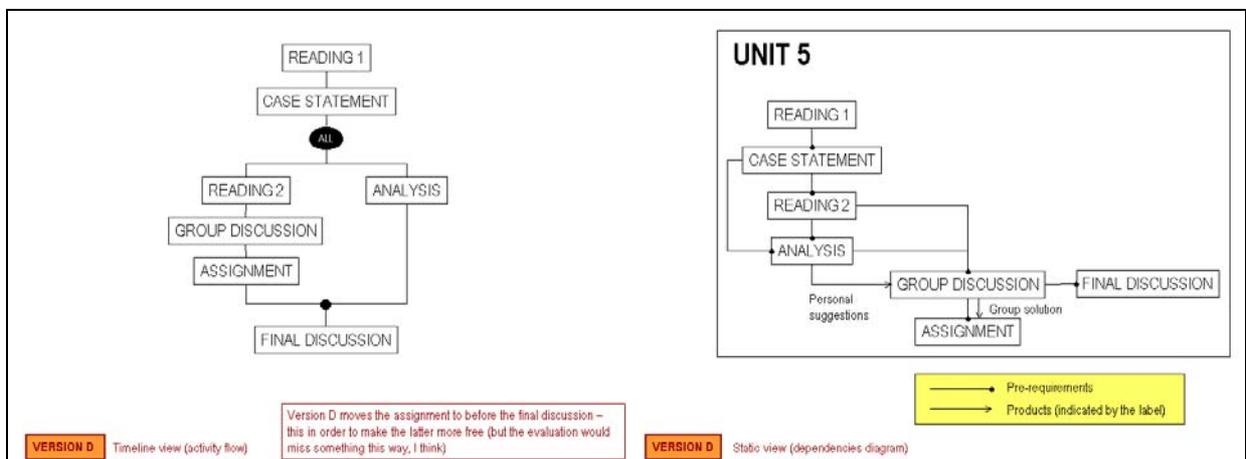


Figure 4.1.10 - UNIT 5, version D

The different versions were used as brainstorming support, but were not developed into any further detail with action diagrams. Although they do not exhaust the range of potential solutions, each alternative version represents a different way of implementing online case-based instruction. E<sup>2</sup>ML can offer a lightweight tool (with respect to developing course materials or prototyping) for exploring alternatives.

### Points of Interest

This first case study does not present a full integration of E<sup>2</sup>ML in the design process, as the following case studies will do. Nevertheless, some important elements emerged.

1. The QUAIL model was used for disambiguating and classifying the course goals.
2. E<sup>2</sup>ML showed a great flexibility in representing the course at different levels (blocks and units)
3. Overview diagrams and activity flows were used for creating different alternative versions of the same unit of instruction, each sensible in emphasizing a different strategy or pedagogical concern. This may support brainstorming and decision-making. In another context, it is a powerful tool to let novice designers see and appreciate differences.

## ISTITUZIONI 3 @ USI, Lugano

<b>Institution</b>	University of Lugano, Faculty of Communication Sciences (Switzerland)
<b>Design situation</b>	Redesign from a lecture-based course
<b>Topic</b>	Institutional Communication
<b>Delivery type</b>	Blended learning
<b>E<sup>2</sup>ML version</b>	Core
<b>Role of E<sup>2</sup>ML</b>	Design + development
<b>Abstract</b>	This course in institutional communication was restructured in a blended-learning form for being offered to a new public of more advanced students. The course exploited multimedia materials and took the media education theory as a reference point. The design took place in a very short timeframe.

### The Course

*L'Istituzione nel Contesto della Società (The Institution in the Framework of Society)* is course in institutional communication delivered within the Curriculum of Communication Sciences at the Università della Svizzera italiana in Lugano (USI). Its original version, presented in the next case study, is a mandatory course for all freshmen in the faculty of Communication Sciences. This version of the course was developed with the purpose of adapting the course to students in the 3<sup>rd</sup> year, attending to the specialization of Communication and Education. We'll call it *Istituzioni 3* for short. As a standard course in the Faculty, the course takes 56 hours in 14 weeks, and has a final examination. The original course was held as a standard flow of class lectures and discussions.

PowerPoint slides had been developed for the original course along with a set of multimedia materials. It consisted of 22 collections of multimedia elements, called *case studies*; each presenting a variable number of digital documents in various media formats (newspaper articles, videos, audio documents, WWW links) concerning a single institution. The case studies were grouped according to the type of institution (state institution, institutions promoting cultural values, local institutions, etc.), and were available from the course Web site in a password-protected area. In the original course, they were used for drawing lively examples during classes and for a personal activity, mandatory for each student, which will be presented in the next case study.

### Issues

The design of Istituzioni 3 must cope with the following issues:

1. The tight schedule for the course, given the agenda of the students (some were having an internship abroad or in other Cantons, others were attending extra-courses).
2. The will of students in the 3<sup>rd</sup> year to play an active role in courses, not just being lectured (as different from freshmen).
3. The chance offered by a small class (8 people).
4. A short time for redesign: the decision to offer the course to 3<sup>rd</sup> year students was taken in October 2002, and the course was to start in November 2002, one month later.

### Proposed Solutions

Given the full agenda of the students in the 3<sup>rd</sup> year, a blended learning methodology was selected as the most adequate. All efforts were done in order to require a minimum of face-to-face classes, while enhancing independent self and group learning.

The low number of students (8) also allowed an extremely flexible solution in terms of organization and student control. Assistants had enough resources to provide personal tutoring to each student.

The tight schedule for design compelled the greatest possible reuse of existing materials (slides and case studies). In order not to be driven by the materials to re-adopt the original format, a new set of

activities were created, in which the materials were to be exploited in a new way, for responding to the different needs of more advanced students.

Given the competence of students with the Internet and with media development (as students in Communication Sciences), the key strategy was *media education*: use the media artifacts collected in the case studies as words of a language that students could use to describe an institution. In other words, to let students get insights of single institutions and acquire the necessary concepts by working actively with the multimedia documents available (eventually creating or retrieving new ones) in order to create a presentation of that institution.

## **Design**

### *Design Structure*

The design was structured in the following points:

1. A minimal set of face-to-face lectures for introducing main topics and basic concepts.
2. Individual and group activities for understanding concepts and working on case studies.
3. A large media development group activity focused on a single institution for each group of 3 or 4 people.

Assistant tutoring was then configured as a fundamental support to be provided for points 2 and 3.

### *The Design Process*

The design activity for Istituzioni 3 was initiated by the professor, and was conducted with the support of the 2 assistants and one instructional and media designer.

The curriculum definition of the Faculty provided the general requirements for the course, i.e. a total of 56 hours in 14 weeks. No learner requirement analysis was necessary, as the professor and the assistants personally knew all the students.

The redesign started identifying the issues stated above, peculiar of the situation, and by explicitly stating learning goals. After a couple of preparatory meetings with the professor, where the topic for the lectures and the goals for the activities were set, the whole design process was left to the assistants and the designer. It lasted two months (with a partial overlap with the first course sessions), and could be split into two phases:

1. Phase 1: the preparation of lectures and small activities.
2. Phase 2: the preparation of the media development group activity.

No particular material development was foreseen, given the short timeframe available: the slides were undergone minor revisions by the professor and one assistant, while the case studies were used “as is”, with new guidelines scaffolding the activities. Additional lightweight materials were set up for other activities.

The media development group activity was finally conceived as the redesign of a single case study: each group of 3-4 students was assigned an institution. The group should then take the collection of multimedia materials in the case study and re-structure it according to a particular perspective (e.g. showing the internal and external communicative processes of that institution, or the development of its mission and vision). This basically meant:

1. Define groupings of documents (all original collections were structured the same way: articles, videos, audios, Web sites).
2. Eventually create or find new documents.
3. Writing new introductions to all documents.
4. Write an introduction to the collection, specifying a suitable study perspective.

The output of the activity was a complete online case study potentially ready to be used by first year students.

The small activities were three:

1. The analysis and classification of a single institution (a personal work followed by an online forum discussion).
2. Studying and presenting one metaphor for describing complex organizations, taken from Morgan's book *Metaphors of the Organization*. The presentation were done in class and then discussed with all the students.
3. A project-management practice session, where a potential plan for marketing a master program was to be developed and discussed (the goal here was not formal project management, but understanding the complexity of such a process).

More will be provided in the action diagram section.

### *Role of E<sup>2</sup>ML*

The designer mastered E<sup>2</sup>ML and used it during the whole process to keep track of the design and to develop the materials (also rearranging the case studies). A precise tracking was also useful as the design of the final events of the course was completed *during* the course itself, and the E<sup>2</sup>ML documentation helped maintaining the overall consistency of the instruction.

During the course the activity flow and the dependencies diagram were useful for a correct rescheduling of some events that must be moved.

### **Goal Definition**

The goals for Istituzioni 3 were defined by the professor, the assistants and the designer. Their definition began with a brainstorming session, which started with the informal expression of the goals for the original course version as reported in the slides for the first lecture. These were then refined working with the QUAIL model, and G7 was added to the original goals. They were then formulated in a more structured way and discussed in a second session for approval.

### *Goal Statement*

GOAL STATEMENT						
TAG	STATEMENT	TARGET	STAKEHOLDER	APPROACH	ASSESSMENT	IMP.
G1	Name and define concepts of organization theory for institutions (basis for describing institutions)	All students	USI, instructor	Explain and discuss	Written exam (define concepts + discuss them)	4
G2	Understand a framework for the categorization of institutions (basis for classify institutions)	All students	USI, instructor	Examples	Group work 1 + discussion + exam	4
G3	Describe, classify and compare institutions	All students	USI, instructor	Examples	Group work 1 + discussion	5
G4	Analyze and understand complex institutions and figure out possible solutions to critical issues	All students	USI, instructor	Case studies, problem solving	Written exam: case study + case study work	4
G5	Develop interest in institutions and institutional communication (a possible professional field)	All students	USI (V ind.), instructor	Unspecified (show the role of communication)	Whole course (personal engagement)	3
G6	Recall relevant examples and best practices of institutions	All students	Instructor	Examples	Group works and case study work	4
G7	Learn to develop multimedia learning materials (about institutional communication)	All students	Instructor, students	Guided practice, problem solving	Case study work	3

Table 4.2.1 - Istituzioni 3: goal statement

## Goal Mapping

Goal mapping was developed according to the QUAIL model.

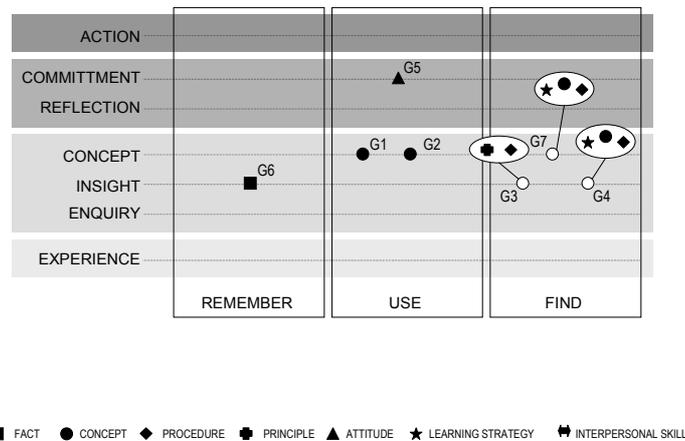


Figure 4.2.1 - Istituzioni 3: goal mapping

Notice that goals indicate only a small component of factual knowledge (G6). G3 and G4 are on the *insight* level as they consider the description and analysis of single instances of institution (as opposed to a general schema for institutions – which is represented by G2). Moreover, G3, G4, and G7 are placed in the *find* scope, as they concern creative cases (previously unknown institution and the production of new multimedia materials).

## Overview Diagrams

### Dependencies Diagram

Basically, Istituzioni 3 is composed by:

1. Three lectures.
2. Two online units (one individual activity and one group activity).
3. Three discussion events (one is a final discussion).
4. The multimedia development activity (labeled MM), which includes several sub-activities of design, revision and technical support.
5. The exam.

The dependency diagram (Figure 4.2.2) was used for grouping actions according to their delivery mode – lectures, online activities, discussion and the final group work. This helped in following the implementation plan. The prerequisite relationships reveal the intertwined structure of lectures, activities and discussions. The MM activity on the other hand is an almost streamlined process.

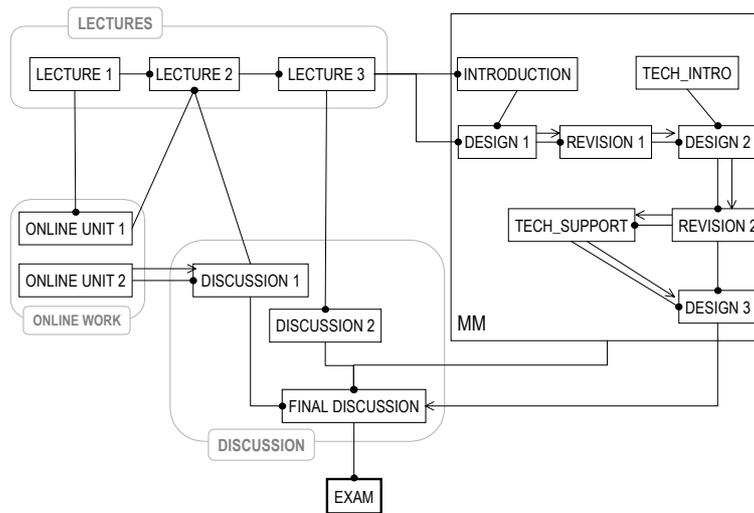


Figure 4.2.2 - Istituzioni 3: dependencies diagram

Another version of the dependency diagram (Figure 4.2.3) was developed using a color key for assigning development responsibilities to the team members. This is an interesting example of flexible use of E<sup>2</sup>ML.

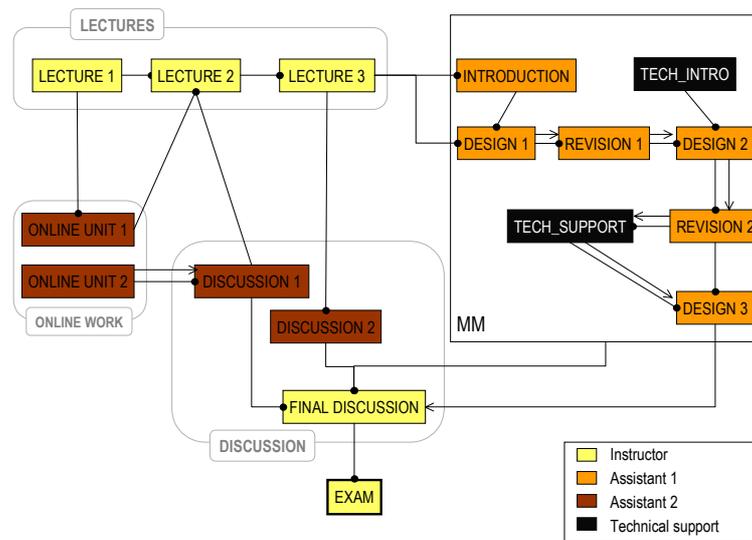


Figure 4.2.3 – Istituzioni 3 - colored dependencies diagram

### *Activity Flow*

The activity flow (Figure 4.2.4) shows the streamlined nature of the course. The greatest part of actions is to be completed within periods, leaving the students a sort of “local flexibility” yet allowing synchronization moments in lectures and discussions.

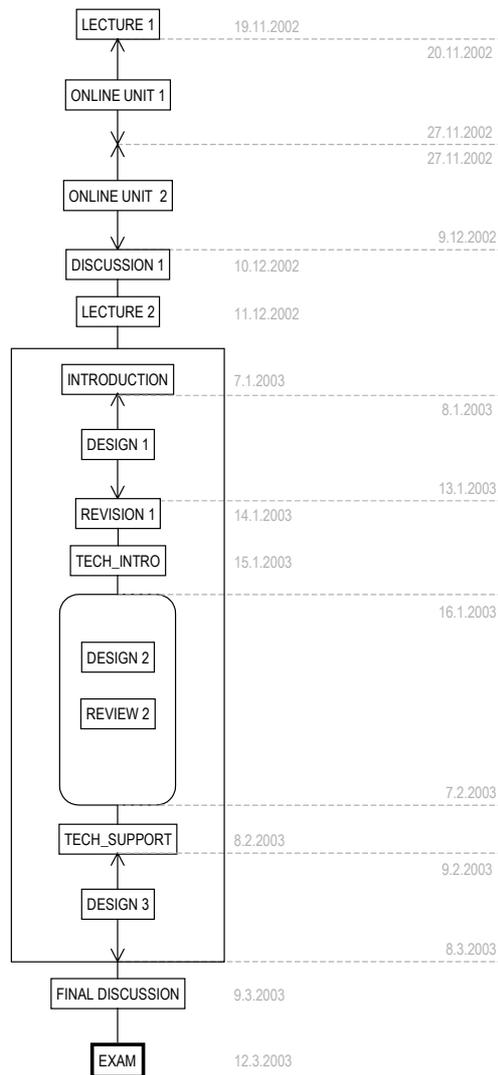


Figure 4.2.4 - Istituzioni 3: activity flow

Notice that line dates are used for indicating timeframes in which students had to complete activities, and single dates for specifying class sessions.

The activity flow was used as discussion tool during the design, and during the course for coping with the several necessary rearrangements of the calendar.

### Action Diagrams

Generally speaking, all actions shared some common features:

1. All face-to-face actions took place in the same classroom.
2. All distance learning actions exploited:
  - a. The course Website (developed with WebCT), including the discussion forum.
  - b. The online multimedia case studies.

Notice that E<sup>2</sup>ML Core Version does not provide resource lists to describe roles, tools and locations, as the Advanced Version does. This actually suits to the current situation, as it does not present particular issues. The roles involved in the course were the professor (holding the lecture and the final exam), two assistants (providing personal support and leading the small activities) and a technical support person (for the final MM activity). Tools are described in the action diagram section. Locations do not require any further explanation.

Lectures were modeled as shown in Figure 4.2.5. All of them took place in classroom A34, and the only tools required were slides. Notice that slides are indicated according to the *modules* defined for the original version of the course. The identification of what modules were to be used in the three lectures facilitated the revision. Notice that LECTURE 1 also serves as introduction to the course, and presents the MOT and INFO goals.

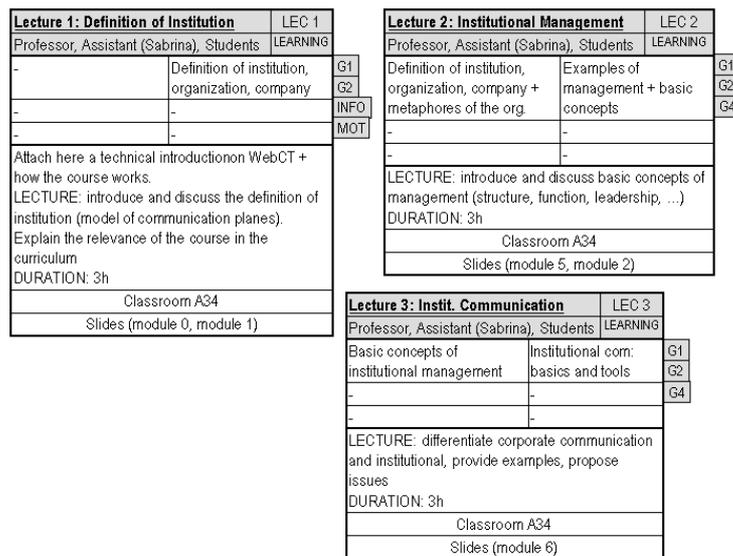


Figure 4.2.5 - Istituzioni 3: lectures (action diagrams)

The online units details are provided in Figure 4.2.6. Before analyzing them, it is worthwhile to spend some words on the case studies, reused from the original course version, and widely used in the activities and in the MM activity. Case study means here a collection of digital documents concerning a single institution. Each case studies organizes documents according to their format (text, video, audio, Web site), and then chronologically. All case studies were available online (password protected) from the course Web site.

The online units are the development of the small activities presented before: ONLINE UNIT 1 is the classification and discussion activity; ONLINE UNIT 2 is the first part of the “metaphors of the organization” activity. The two of them exploited the WebCT environment, and relied on materials prepared in advance by the assistants (ONLINE MODULE 1 and 2). Notice that a third online unit were foreseen, but was not developed due to time constraints. Students could perform all online units at any location, as the only necessity was an Internet access.

Typologies of Institution		ONLINE UNIT 1
Students (all, single)		LEARNING
Definition of institution. Framework of categorization	Critical view of the categorization framework + knowledge of the assigned inst.	G2 G3
Know how to use WebCT	-	
Read PDF text + analyze & classify the assigned institution using the multimedia case study as starting point + post in the forum + discuss in the forum in the following days DURATION: 4h		
Anywhere		
Online module 1, Case studies, Course Web site, Forum		

Metaphors of the Organization		ONLINE UNIT 2
Students (in free groups of 2 or 3)		LEARNING
Definition of institution	5 metaphores for organizing the institution (critically discussed). Basic concepts of management	G1
Know how to use WebCT + PowerPoint	-	
Morgan's book chapter	Presentation for GW1	
Read the suggested Web site + the assigned chapter by Morgan. Prepare a presentation explaining the metaphor and presenting the University of Lugano according to it DURATION: 4h		
Anywhere		
Online module 2, Course Web site, Morgan's book, Forum		

Historical and sociological studies on the concept of "institution" (G2) NOT DEVELOPED
---

Figure 4.2.6 - Istituzioni 3: online units (action diagrams)

The two discussions during the course are as follows (Figure 4.2.7). Notice that DISCUSSION 2 is the collaborative problem-solving session (marketing a master program), guided by the assistants. DISCUSSION 1 concludes the work on Morgan's book initiated in ONLINE UNIT 2.

Metaphors of the Org. (discussion)		DISCUSSION 1
Students (free groups 2/3), Assistants		LEARNING
Definition of institution.	Deep knowledge of one metaphor + matching with a real case	G1
Presentation skills, PowerPoint	Discussion and presentation skills (feedback in the forum)	
DISCUSSION: Each group presents its work (OS2) on one chapter <i>Images of the Organization</i> + discussion DURATION: 2h		
Classroom A34		
Morgan's book		

Institutional communication		DISCUSSION 2
Students, Assistants		LEARNING
Basic concepts of institutional management + institutional communication	Examples of practice in inst. communication. Experience of issues	G4
PowerPoint and Word (basics)	Discussion and presentation skills	
Problem statement	Problem solution	
PROBLEM SOLVING: A case study is presented, concerning institutional communication (communication of a new master in a HE institution). A plan is developed and each group solves a task. DURATION: 2h		
Classroom A34		
-		

Figure 4.2.7 - Istituzioni 3: discussions (action diagrams)

The MM activity, which tool almost half the course time (as shown in the activity flow), was generally described as in the following diagram. Among the tools, notice the MJB suite, a collection of scripts that was used as scaffolding for the development of the reformulated case study (Botturi, Inglese & Rozalén 2003).

Case Study Reformulation		MM
Students (in groups of 3), Assistant, Tech. Support		LEARNING
Whole course	Deep understanding of one institution + of a specific part of the course	G2 G3 G4
JavaScript basic + HTML basic + MJB	Web programming competencies + groupwork	G7
A multimedia case study	The restructured version of the case study	
PROBLEM SOLVING; View all materials + analyze it with course concepts. + Restructure it by matching with course concepts + implement it (MJB) +Periodic review with assistants DURATION: 40h		
Classroom A34 + PC room 159 + anywhere		
Course Web site, Case Studies, the MJB suite, Activity guidelines		

This is a macro-action, articulated into the following sub-actions:

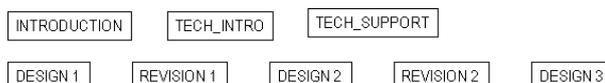


Figure 4.2.8 - Istituzioni 3: MM activity overview (action diagram)

The details for each sub-action are given in the following action diagrams.

The INTRODUCTION offered a discussion of the goals of the work by linking the activity to the course objectives and to the concepts discussed during the lectures, the creation of groups and explained the guidelines of the activity (which were reported in the course Web site). The assignments were also decided in this session. Students were divided in three groups, and each group could select the institution on which to work from a list of six. The selected institutions were: UNO, International Red Cross, and ETHZ (Zurich Technical University).

MM: Introduction		INTRODUCTION
Students (in groups of 3), Assistants		LEARNING
Concepts from L1, L2, L3	Understanding of the assignment for MM	G2 G3 G4
-	-	INFO
MM assignment document	-	
Present the MM work, form groups, define assignment, present deadlines and expected result + evaluation criteria DURATION: 30 min.		
Classroom A34		
Course Web site, Case studies, Activity guidelines		

Figure 4.2.9 - Istituzioni 3: MM activity introduction (action diagram)

After the introduction, the activity proceeded in two main rounds of design by the group and revision with the assistants. The first round, reported below, consisted in the analysis of the available documents and the preparation of a paper-and-pencil draft project of the whole work (getting “the idea” for the project).

MM: Design 1		DESIGN 1
Students (in groups of 3)		LEARNING
Assignment understanding	Matching with the analysis of one case study	G2 G3 G4 G7
Use MS Word or PowerPoint	-	G7
MM assignment document	Paper project (MS PowerPoint / MS Word)	
View the assignment and the case study, think categories, select and retrieve materials, draw a diagram of the new case study		
DURATION: 7.5 h		
Anywhere		
Course Web site, Case studies, Activity guidelines		

MM: Review 1		REVISION 1
Students (in groups of 3), Assistant		SUPPORT
Project idea	Revised project idea (check of responsiveness to the assignment)	G2 G3 G4 G7
-	-	G7
Paper project (draft)	Corrected paper project	
Review the project, discuss goals, ideas and available materials. Discuss possible alternative solutions with the students and help them taking a definitive choice.		
DURATION: 1h per group		
Assistants' Open Space		
Case studies		

Figure 4.2.10 - Istituzioni 3: MM activity design and revision round 1 (action diagrams)

The second round, which was preceded by the technical introduction to the use of the software selected for the activity (the New Media Juke Box suite), consisted in a prototype of the final application. The DESIGN 3 activity took finally place after the second review.

MM: Design 2		DESIGN 2
Students (in groups of 3)		LEARNING
Project idea	Implementation with MJB	G2 G3 G4 G7
Use MJB	Improve JavaScript and HTML programming	G4 G7
Paper project	Demo	
Take the project, retrieve eventual new documents, implement a demo with MJB, test it.		
DURATION: 4h		
Anywhere		
Course Web site, Case studies, Activity guidelines, MJB suite		

MM: Review 2		REVISION 2
Students (in groups), Assistant, Tech		SUPPORT
-	-	G2 G3 G4 G7
-	-	G3 G4 G7
Demo	Corrected demo	
Review the project		
DURATION: 1h per group		
OS		
-		

MM: Design 3		DESIGN 3
Students (in groups of 3)		LEARNING
Corrected demo	Final implementation	G2 G3 G4 G7
Use MJB	Improve JavaScript and HTML programming	G3 G4 G7
Demo	Final product	G7
Take the demo and refine it according to MMR2 suggestions.		
Anywhere		
-		

Figure 4.2.11 - Istituzioni 3: MM activity design and revision round 2 (action diagrams)

Notice that reviews are indicated as *support* activities. This is done according to the IMS definition of activities that are performed once for each student (group in this case). Nevertheless, one could argue that they are at all effects real *learning* activities: students in fact often learn more from these scaffolding sessions than in e.g. lectures.

The technical support was indeed a delicate issue: learning to use any software application is time-consuming, and is not among the course goals. Nevertheless, no final product could be obtained without dealing with technical details (actually, students required a discussion to understand why they were asked to “code” and get a final product. In the end, they were enthusiastic about the work, as

seeing one's own multimedia collection running provided the kind of reward that can effectively reinforce learning).

The support was concentrated in two moments: a first introduction to the use of software prior to the prototyping (DESIGN 2) and a day-long collaborative work where groups could work together with the technical support in troubleshooting all details and refining the prototype according to their original idea. In these sessions, which took place in the computer lab, the technical support (tech) played the main role.

MM: Technical Introduction		TECH_INTRO
Students (in groups), Assistant, Tech		LEARNING
-	Learn to use MJB	G7
-	-	
MJB test-base	-	
Introduce the MJB + explain how to use it + do exercises		
DURATION: 2h		
PC lab 159		
Case Studies, MJB		

MM: Technical Support		TECH_SUPPORT
Students (in groups of 3), Tech		LEARNING
Basic with MJB	Learn to use MJB fluently	G7
-	-	
Case study prototype	Refined prototype	
COLLABORATIVE WORK: rehearse basic of MJB, introduce tips. Work with groups on the implementation; help groups identify technical solutions for their ideas.		
DURATION: 6h		
PC lab 159		
Case studies, MJB suite		

Figure 4.2.12 - Istituzioni 3: MM activity technical support (action diagrams)

The result of each group for the MM activity was therefore an online case study about the selected institution. A screenshot from one of them is reported in Figure 4.2.13.

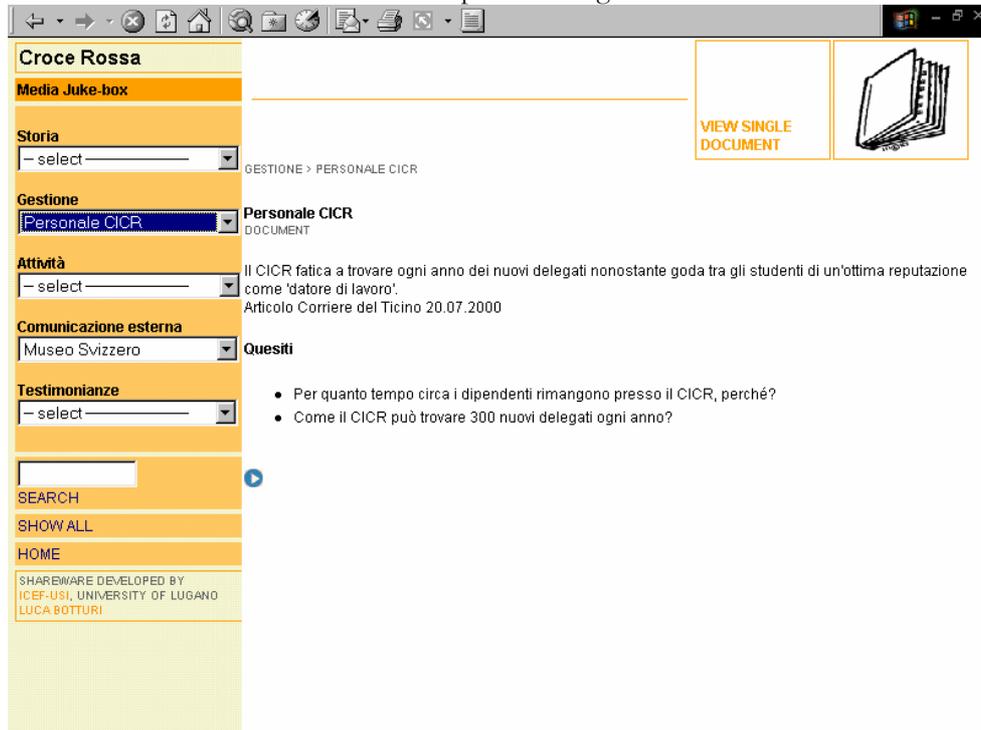


Figure 4.2.13 - A screenshot from one of the case studies

Finally, two face-to-face activities concluded the course: a final discussion, which fixed the basic concepts of the course and evaluated the course itself, and the final exam, which consisted in the presentation of the MM result and answering to some questions by the professor.

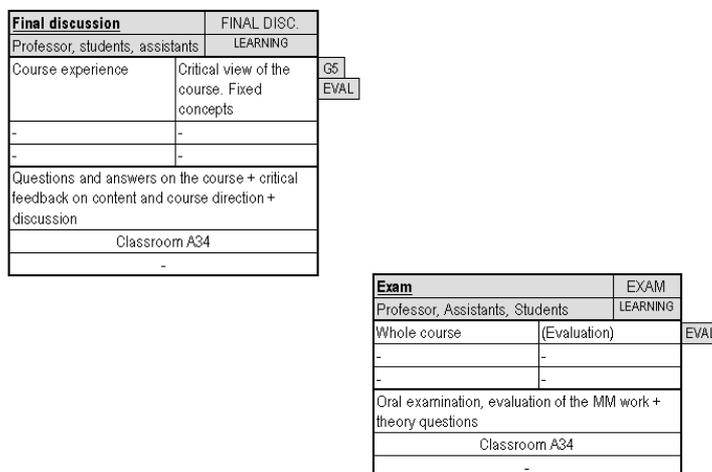


Figure 4.2.14 - Istituzioni 3: concluding activities (action diagrams)

## Outcomes

The general outcome of Istituzioni 3 was assessed through interviews with the students. They appreciated the organization of the course, although unusual in their academic context. The hypothesis of media education was proved to be effective: learning goals were achieved, as the exam confirmed, and students got the experience of “doing things”, even in a partially conceptual subject matter as institutional communication.

Moreover, the side effect of learning to design and produce a multimedia collection was felt to be an important competence.

Finally, the flexible schedule, and the reduction of face-to-face meetings to a minimum were appreciated as a valid response to the complex time-management of that particular student group.

## Points of Interest

Istituzioni 3 is an interesting example as it shows how E<sup>2</sup>ML can support rapid design activities and enhance the overall consistency.

This blended-learning situation also reveals the flexibility of the language, which is expressive enough both for technology-free and technology-based activities. Notice that different types of activities are here modeled seamlessly: simple lecturing, discussions, group work and design and revision processes. From a more formal and semantic point of view, the design documentation shows the complementarities of the dependency diagram and the activity flow: their structure is here clearly different yet represent the same object from two different points of view. The extension of the dependencies diagram with a color key for assigning development responsibilities to the team members makes it an interesting project management tool.

Finally, the structure of the MM activity could be generalized into a collaborative *atelier work* pattern to be reused for further designs.

## ISTITUZIONI 1 @ USI, Lugano

<b>Institution</b>	University of Lugano, Faculty of Communication Sciences (Switzerland)
<b>Design situation</b>	Design from scratch of a new course
<b>Topic</b>	Institutional Communication
<b>Delivery type</b>	Face-to-face + online activity
<b>E<sup>2</sup>ML version</b>	Advanced
<b>Role of E<sup>2</sup>ML</b>	Design + development (partially as reverse design)
<b>Abstract</b>	The professor's idea of exposing students to direct contact with real-life institutions, led to the design of a set of multimedia materials to be used for case studies. The course was then built as a parallel of classroom sessions and online activities.

### The Course

The course *L'Istituzione nel Contesto della Società* was introduced at the University of Lugano in Summer Semester 2002. The idea was to provide students in the first year of Communication Science an introduction to the world of institutions, exactly as they were provided an introduction to the corporate world. Their profile is in fact interesting for a number of potential jobs in institutional communication and management. The design of the course started one semester (4 months) before the course start. The result was *Istituzioni 1*, the original course that was then developed into *Istituzioni 3*, as reported in the previous case study.

The basic tenet of the professor's disciplinary approach was that, due to their degree of complexity and heterogeneity, institutions could hardly be described in one thorough model, while experience can be a good teacher. All the same, students in the first year do not have any competence for an internship or collaboration with a real institution. The course therefore tried to provide opportunities for a "direct look" into real institutions via multimedia documents, guided and integrated with a theoretical framework.

The course was to be taught to a class of about 160 students, all in their first year, i.e. with scarce background in communication and management, but generally highly motivated and enthusiastic.

#### *Issues*

No particular issues were identified for this course, if not the commitment to translate the professor's idea into a lively instruction. This included his interest in systematically collecting student feedback, which raised a challenging issue, given the large class size.

#### *Proposed Solutions*

The professor's approach was translated into a double-track program:

1. Presenting some general concepts about institutions and institutional management and communication.
2. Providing the most possible lively picture of the life of real institutions through examples and case studies.

The device for implementing that was multimedia: using video, texts, images and Web sites in order to give the students a chance to work with real information and to approach the complexity of institutions. As the course was to be experimental in its use of multimedia, special attention was paid to collecting feedback in order to conduct the formative evaluation.

## Design

### Design Structure

The first track was pursued mainly through classroom lectures (two lectures of two hours each week, in the university standard 14 weeks' semester). Lectures were used for frontal explanation, discussion, examples, and all the activities usual to this setting. After the lecture, the slides and the other materials were available on the course Web site.

The second track was developed into a set of 22 multimedia case studies, each presenting a single institution (such as the UNO, Amnesty International, CERN, etc.) through a collection of digital documents (texts, audio and video clips, Web sites - from 10 to 60 per institution). Technically, the case studies made available with the New Media Juke-Box (Botturi, Inglese, Rozalén 2003). They could be accessed online in a password-protected area of the course website, which also provided the slides presented during the lectures, a reference list, and an online lecture synthesis and assessment form for each lecture. The materials for the case studies were developed in collaboration with RTSI – Radio Televisione della Svizzera Italiana. A complete account of the multimedia development for this course is provided in (Botturi, Inglese, Rozalén 2003). A screenshot of a case study about the Swiss Post is reported in Figure 4.3.1.



Figure 4.3.1 - Istituzioni 1: case study screenshot

By the week before the end of the course (if the exam was to be completed in June; after the Summer if in October – this was up to the student's choice), students had to perform a double analysis of the case studies, called *dossier*:

1. An *extensive analysis*, i.e. analysing three documents for each institution in a selection of 17 out of 22 (the selection was up to the student).
2. An *intensive analysis*, i.e. of a whole case study and all its multimedia documents.

The results of the two analyses were to be submitted in the form of a written report. The case studies were also used for drawing examples or cases for discussion in class.

The feedback issue was tackled as follows. Each week students had to fill in a weekly feedback form on the course Web site, composed by two elements: a wrap-up of the lecture (five keywords and a ten-line summary) and the assessment of the lecture and of the materials used in it. This was done also in order to provide the students with a chance to consolidate the lecture concepts.

The evaluation was in part (40%) from the report of the dossier activity, and in part from the final written exam (60%).

### *The Design Process*

The professor led the design activity. He had the support of an assistant (expert in institutional communication); a media designer, who was in charge of retrieving, selecting and digitizing the materials for the case studies; and an instructional designer and media developer, who helped figuring out the activities and implemented the necessary software.

Given the standard situation of an undergraduate course and the detailed knowledge of the context of all team members (all of them had worked in the Faculty since at least 4 years), no formal analysis phase was necessary.

The whole design process lasted four months. The overall course structure and the activities were promptly defined in the first month, and served as requirements for the great effort in implementing the case studies.

### *Role of E<sup>2</sup>ML*

The instructional designer mastered E<sup>2</sup>ML and used it to keep track of the design, mainly for making decisions accountable. The design team did not therefore use E<sup>2</sup>ML actively. The documentation produced (partially as reverse design) was also useful for starting and quickening the redesign process for Istituzioni 3.

## **Goal Definition**

Goals for Istituzioni 1 are the same as Istituzioni 3, except for G7, which is here not present, and for a slight change in the importance values. Only the goal statement (Table 4.3.1) and mapping (Figure 4.3.2) are therefore reported without replicating the discussion proposed in the previous case study.

### *Goal Statement*

GOAL STATEMENT						
TAG	STATEMENT	TARGET	STAKEHOLDER	APPROACH	ASSESSMENT	IMP.
G1	Name and define and concepts of organization theory for institutions (basis for describing institutions)	All students	USI, instructor	Explain and discuss	Written exam (define concepts + discuss them)	4
G2	Understand a framework for the categorization of different institutions (as basis for classify institutions)	All students	USI, instructor	Examples	Written exam: questions	4
G3	Describe, classify and compare institutions	All students	USI, instructor	Examples	Dossier	5
G4	Analyse and understand complex institutions and figure out possible solutions to critical issues	All students	USI, instructor	Dossier	Dossier + Written exam: case study	3
G5	Develop interest in institutions and institutional communication (also as a possible professional field)	All students	USI, instructor	Unspecified (show the role of communication)	Whole course (personal engagement)	3

G6	Recall relevant examples and best practices of institutions	All students	Instructor	Dossier	Dossier + Written exam: questions	4
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Table 4.3.1 – Istituzioni 1: goal statement

### Goal Mapping

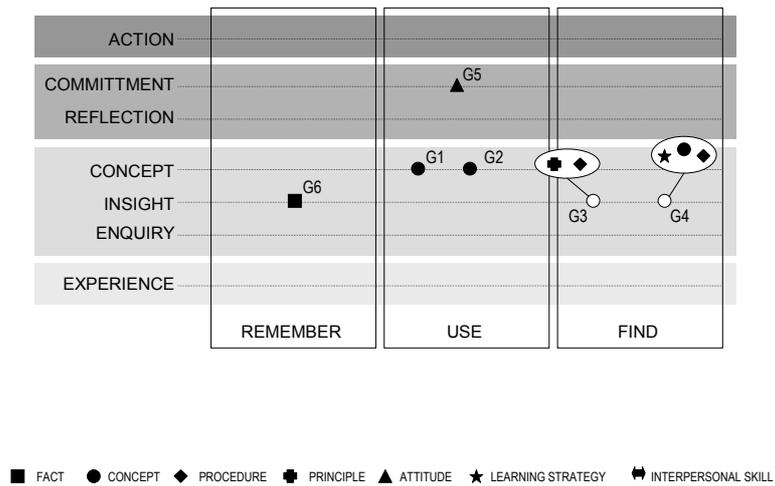


Figure 4.3.2 – Istituzioni 1: goal mapping (QUAIL)

### Overview Diagrams

#### Dependencies Diagram

The overall structure of this course is very clear (Figure 4.3.3): a set of 14 weekly modules (M1 to M14) and the analysis activities, called DOSSIER, plus the final exam.

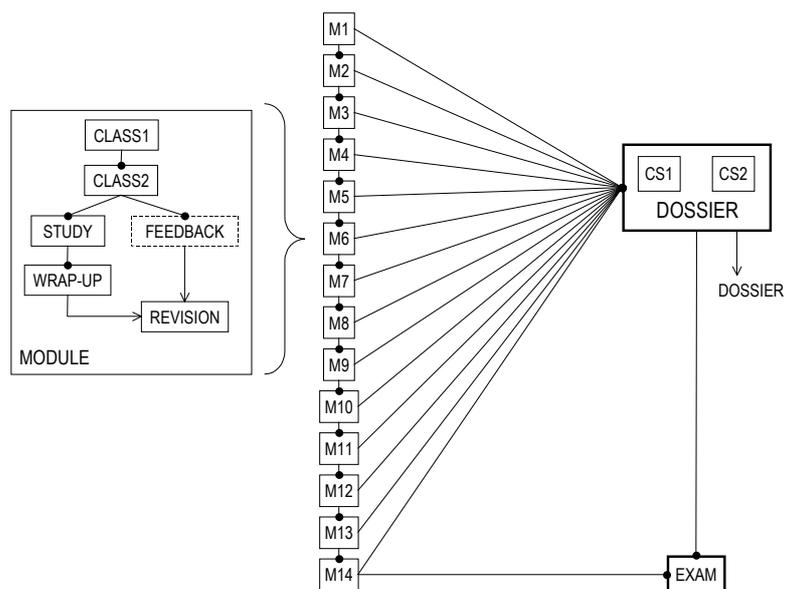


Figure 4.3.3 – Istituzioni 1: dependency diagram

Each weekly module is composed by:

1. Two lectures (of 2 hours each).
2. Personal study.
3. The feedback, composed by the online wrap-up and the very feedback on the class sessions.
4. A support activity of revision by the assistant.

All weekly modules form a sequence, and all of them are prerequisites for the *dossier* activity. We will later on see that this will generate some issues in scheduling.

### *Activity Flow*

The activity flow (Figure 4.3.4) reveals the relative scheduling of weekly modules and of the dossier. The dossier work was presented in week 5, and run then parallel to classes as personal student work, with the support of the assistant, and with eventual questions and answers during classes. This situation, which was detected thank to the overview diagrams, actually generated a conflict: the students could start the dossier work in week 5, but they actually achieved all the necessary prerequisites only in week 14. The results were clear in the final grades: students who started earlier the dossier work (those who concluded the exam by the end of the semester in June) got a lower grade; those who postponed the exam and took the time for the dossier work during summer (thus submitting it in September) got higher grades.

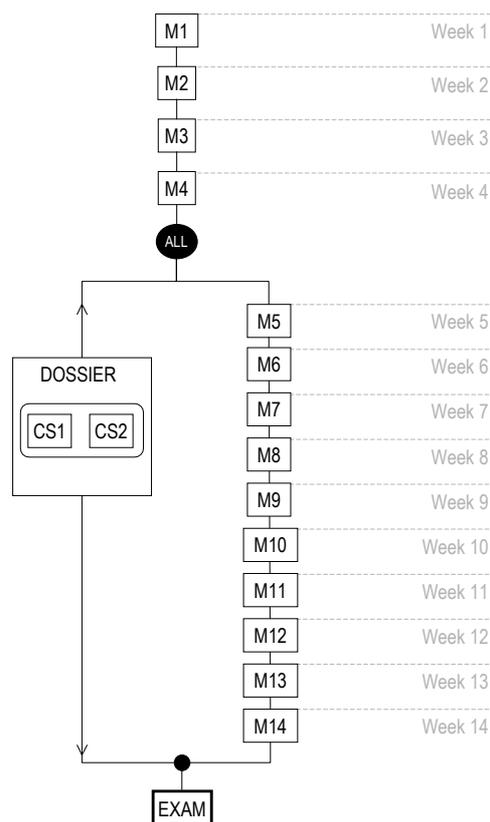


Figure 4.3.4 – Istituzioni 1: activity flow

### Course Breakdown Statement

The CBS was useful in order to pace the development activity for slides and case studies with the course: the development of materials in fact was not completed before the course started, but had an overlap.

Given the modular structure of the course, the CBS is here reported in a contracted form, only showing type actions and unique activities (D, CS1, CS2 and EXAM).

ABS						
TAG	NAME	TYPE	ROLES	LOCATIONS	TOOLS	DUR
Lx	Lecture	LEARNING	L, S, A	A21	LS, CS	2h
Sx	Personal or Group Study	LEARNING	S	Anywhere	LS, CS	1h
Fx	Lecture Feedback	SUPPORT optional	S	Anywhere	SC	3 min.
Wx	Lecture Wrap-up	LEARNING	S	Anywhere	SC	30 min.
Rx	Revise Feedback	SUPPORT	FR, A	OS	SC	1h
D	Dossier	LEARNING	S, A	Anywhere, OS	AG, HP, CS	30h
CS1	Case-Study In-depth Analysis	LEARNING	A, S	Anywhere, OS	AG, HP, CS	15h
CS2	Case-Study Extensive Analysis	LEARNING	A, S	Anywhere, OS	AG, HP, CS	15h
EXAM	Final Exam	LEARNING	S, E	A21	-	2h

Table 4.3.2 – Istituzioni 1: CBS

### Resource Lists

#### Roles & Actors List

Roles and actors are exactly the same as in Istituzioni 3, except for the students and the feedback reviser; they are here reported more formally (staff names have been blinded).

Notice the role of the feedback reviser, who was in charge of coping with the large amount of feedback received every week – this is indeed the counterpart of having regular two-way exchanges with a large class. Also in this case, E<sup>2</sup>ML modeling allowed foreseen the work overload for the assistant and feedback reviser, but no other resource was available. As a result, some feedback was not reviewed before the end of the course.

ROLES				
TAG	ROLE NAME	DESCRIPTION	#	ACTORS
L	Lecturer	Holds the lectures.	1	Eric Straw
A	Assistant lecturer	Holds exercises, provides counseling	2	Sabrina Hernandez
S	Student	Student	160	1 <sup>st</sup> year students in Communication Sciences
E	Evaluator	Evaluates case study work, exercises and the final exam	1	Eric Straw
TS	Technical support	Provides technical support for the course Website, the survey collector and the case studies	1	Luke Mug
FR	Feedback reviser	Take care of analysing student feedback and reporting to the Lecturer	2	Sabrina Hernandez

Table 4.3.3 – Istituzioni 1: Roles & Actor list

#### Location List

The location list only contains two items: the classroom and the assistant's open space, where students could come for asking questions or for discussion.

LOCATIONS			
TAG	NAME	DESCRIPTION	FACILITIES
A21	Classroom A21	Fully-equipped classroom with 180 places	PC, LAN Internet connection, 1 microphone, PC audio output, beamer. 160 places.

OS	Assistants' Open Space	Assistants' desks and a discussion room	-
----	------------------------	---	---

Table 4.3.4 – Istituzioni 1: Location list

### Tool List

Few tools were actually used for this course, but they required a great development effort. Specially, the survey collector was developed on purpose, to suit the needs of the instructor and of the students, and the case studies, which were implemented with the Media Juke-Box suite, were a great investment in terms of time spent for digitizing.

TOOLS						
TAG	NAME	CLASS	DESCRIPTION	AVAILABILITY	MAN.	SUPPORT
HP	Course Homepage	COLLECTION	HTML page providing access to all the course Web resources	USI server <a href="http://www.istituzioni.lu.unisi.ch">www.istituzioni.lu.unisi.ch</a>	TS	USI technical support, via TS
SC	Survey collector	TOOL	ASP online survey for collecting student feedback	USI server <a href="http://www.istituzioni.lu.unisi.ch">www.istituzioni.lu.unisi.ch</a>	TS	USI technical support, via TS
CS	Case studies	CONTENT	22 collections of multimedia documents concerning one institution each	On the USI server, accessible via the course homepage (Password protected)	TS	TS
LS	Lecture slides (7 modules, from MOD0 to MOD 6)	CONTENT	PPT for the lecture, with links to CS as examples	During the lecture + available on the course homepage	A	-
AG	Dossier activity guidelines	GUIDELINE	Short guidelines for action D	In the course homepage, as DOC file	A	-

Table 4.3.5 - Logica: Tool list

Notice that the selection of the Media Juke-Box software for the case studies was determined by its suitability to fast implementation, which was necessary for getting ready 22 cases on time.

### Action Diagrams

Action diagrams for Istituzioni 1 were used only for modeling the standard weekly module, as a type action, and the dossier activity.

The weekly module takes 5 hours, and is composed by six sub-actions, which are described in Figures 4.3.5 to 4.3.7: the two classes, the personal study, the wrap-up (to be done online, with the survey collector), and the feedback (always online: the survey collector, after the wrap-up was done, asked the students if s/he wanted to provide some feedback); finally, the revision of feedback took place.

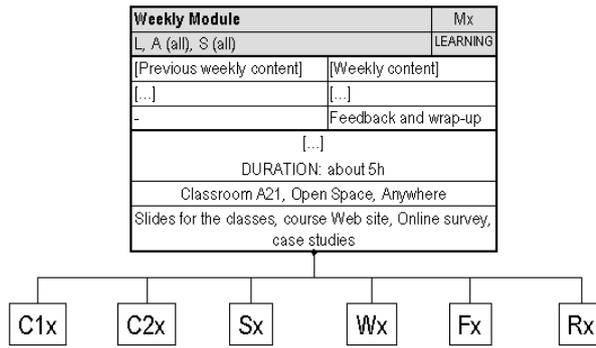


Figure 4.3.5 - Istituzioni 1: general module (action diagrams)

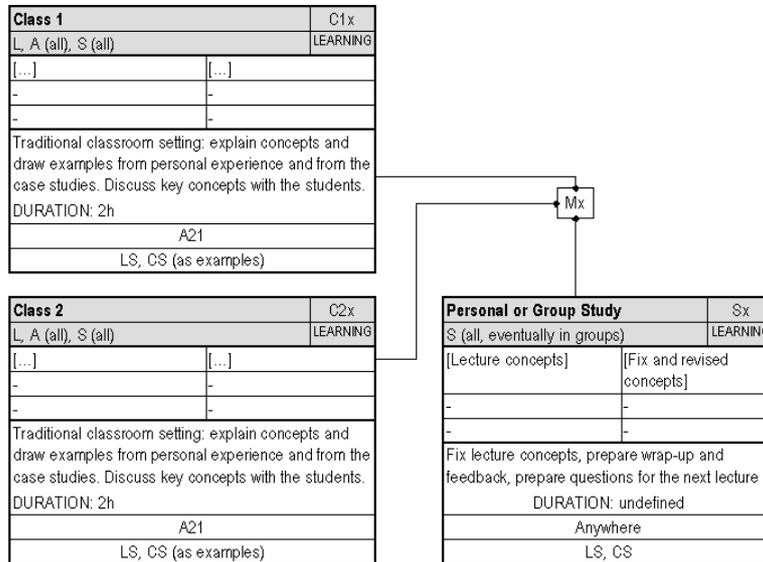


Figure 4.3.6 - Istituzioni 1: general module details 1(action diagrams)

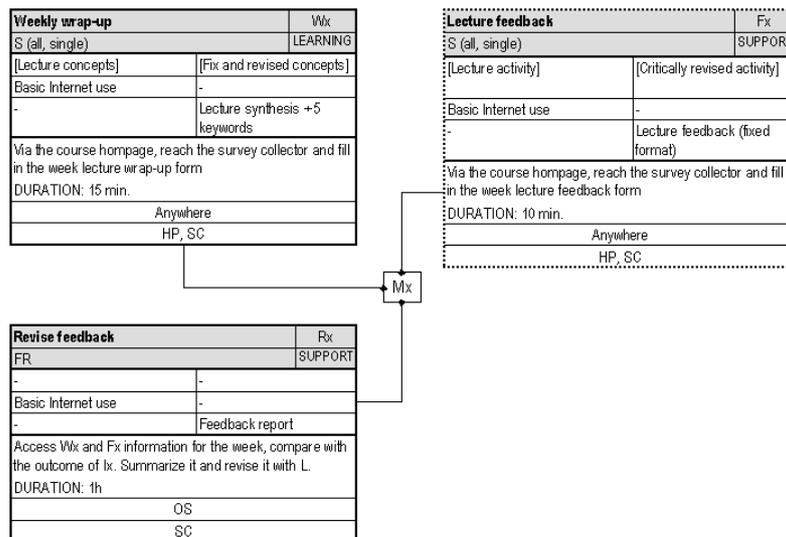


Figure 4.3.7 - Istituzioni 1: general module details 2 (action diagrams)

The DOSSIER activity was modeled as a single instance action, composed by two sub-actions: the intensive report (CS1) and the extensive report (CS2), which corresponded to the two parts of the report to be submitted.

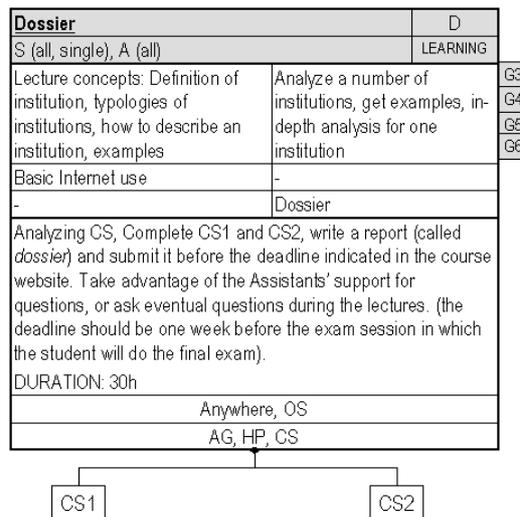


Figure 4.3.8 - Istituzioni 1: dossier (action diagrams)

<b>Case Study In-depth Analysis</b>		CS1
S (all, single), A		LEARNING
Lecture concepts: Definition of institution, typologies of institutions, how to describe an institution, examples	Understand with detail the structure, organization and functioning of an institution, and the issues it is concerned with	G3 G5 G6
Basic Internet use	-	
-	Dossier, part I	
View all the materials of a case study's and analyze it with the course concepts. Ask A for support. Write the dossier and submit it with the CS2 dossier as indicated before the deadline. DURATION: 15h		
Anywhere		
AG, HP, SC		

Figure 4.3.9 - Istituzioni 1: dossier sub-action 1 (action diagrams)

<b>Case Study Extensive Analysis</b>		CS2
S (all, single), A		LEARNING
Lecture concepts: Definition of institution, typologies of institutions, how to describe an institution, examples	Get a general understanding of a number of institutions, compare them, find differences and group them according to the course concepts	G4 G5 G6
Basic Internet use	-	
-	Dossier, part II	
View 3 materials for each case study for 17 out of 22. Analyze them with the course concepts. Ask A for support. Write the dossier and submit it with the CS1 dossier as indicated before the deadline. DURATION: about 15h		
Anywhere		
AG, HP, SC		

Figure 4.3.10 - Istituzioni 1: dossier sub-action 2 (action diagrams)

Finally, the exam required some answer to questions drawing on definitions and examples, and the solution of a case study (problem-solving activity).

<b>Final exam</b>		EXAM
S (all, single), E		2h
Lecture concepts: Definition of institution, typologies of institutions, how to describe an institution, examples	[Evaluation]	EVAL
-	-	
-	-	
Written exam: 1h theoretical questions + 1h case study DURATION: 2h		
A21		
-		

Figure 4.3.11 - Istituzioni 1: final exam (action diagrams)

## Outcomes

From a broad perspective, the development of Istituzioni 1 provided a change of bringing in new competencies in multimedia production, and also initiated collaboration with the RTSI archive. These may be considered “institutional side-effects” of such a challenging design.

One drawback of the design was the uncertainty students developed concerning the evaluation: they were not used, in their second semester, to work on such a large analysis assignment. This was formulated into a commitment of the design team to the development of more detailed guidelines for upcoming editions of the course.

From the point of view of learning, students enjoyed the course and had positive reactions to the multimedia materials. The analysis of the final exams nevertheless revealed a discrepancy between the instructor’s expectations and the actual student achievement. Students in fact worked out the theory, but showed lack of insight in the more practical case study proposed in the second part of the exam. The QUAIL model supported the analysis of such issue. The situation, which clearly involved goals G1, G2, G3, and G4, was sketched out as in Figure 4.3.12:

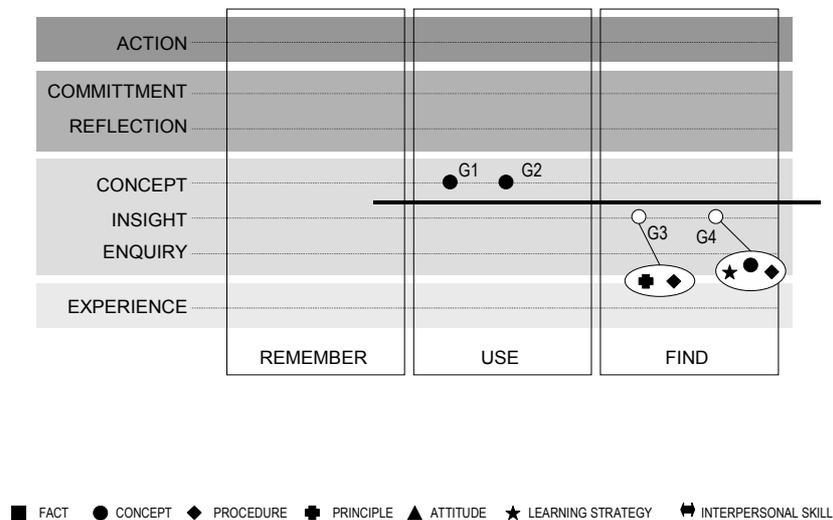


Figure 4.3.12 - Istituzioni 1: Learning outcome diagnostic

The bold line represents the learning gap. The point was that students seemed to achieve G1 and G2, i.e. the theory, but were not able to transfer them into a more creative approach in G3 and G4. Moreover, while general abstract reasoning was clear, the impact with real cases and situations produced problems, and the theory learnt was not felt as a clarifying tool. This was probably due to an “abstract-reasoning” attitude of the students, and at the same time indicated that a more inductive and example-driven approach was necessary, as different from learning definitions as such. The learning progress should proceed, on the QUAIL levels, bottom-up, instead of acquiring concepts starting from the concept level (i.e. through definitions). These indications were kept into account for the following edition of the course. Activities addressing G3 and G4 were therefore redesigned.

## Points of Interest

E<sup>2</sup>ML was here used for modeling a classic classroom-based course. A first example of modular structure was easily modeled with inheritance and aggregation relationships. Another example of that is in the case study *Teleinformatica 1*.

Although simple in its basic structure, this course revealed two issues that were identified in advance thanks to E<sup>2</sup>ML formal modeling:

1. The sequencing issue: students were allowed to work on the *dossier* assignment after week 5, but the following weeks also introduced concepts that were prerequisites for it.
2. The assistant had a period of work overload in catering the feedback coming from the students every week.

Solutions had been identified, but were not put into action due to the scarce flexibility of scheduling. The development of E<sup>2</sup>ML documentation, although not directly used by the design team, proved useful as it provided:

1. A means for archival useful for further developments (namely, the redesign of Istituzioni 1 and the design of Istituzioni 3).
2. The post-course analysis of the learning gap with QUAIL, which offered indications for redesign.

Finally, the comparison of this design with that of Istituzioni 3, which shares the same goals (except G7) may provide interesting hints for the comparison of two different instructional strategies.

## TELEINFORMÀTICA I @ UNIVELS, Milano & EUROCOL, Bogotá

<b>Institution</b>	UNIVELS (Italy) in collaboration with EUROCOL (Colombia)
<b>Design situation</b>	Design from scratch
<b>Topic</b>	Introduction to new technologies
<b>Delivery type</b>	Completely online, videoconference-based
<b>E<sup>2</sup>ML version</b>	Advanced
<b>Role of E<sup>2</sup>ML</b>	Design + development
<b>Abstract</b>	The development of this course has to cope with a number of challenges due to the institutional and learning context: different languages and cultures between staff and students, an inhomogeneous entry level of the students, a distributed development team, etc. Moreover, the course is held completely at a distance and is videoconference-based.

### The Course

UNIVELS's mission is the development of an international cultural and research network. Its first start was the development of an online bachelor program in Management and Economics, connecting European faculties to countries in Latin America. The program started in 2001 with a class of freshmen in Bogotá, Colombia, in collaboration with a local Higher Education institution called Eurocol. The primary target of the program are young men and women that cannot access standard academic programs, mostly for financial reasons. *Teleinformàtica I* is the first course in Informatics in such a curriculum, and it is mandatory for all freshmen. In its third edition, it was completely redesigned for a best fit to the situation, which was evolved from the first start. This design is being accounted here.

The instructional paradigm by UNIVELS<sup>1</sup> is based on videoconference lectures (students can attend to them at home or at the university center) and personal work assisted by tutors. The new situation consisted in an extremely distributed environment: students were grouped at five different locations in Colombia, and each group was given a different tutor (who could be physically met at the locations). UNIVELS has an established technological system for supporting videoconferencing (with Centra Symposium) and asynchronous interaction with online materials, forum and chat (with Studio+ PDL). Course scheduling happens on a 16 weeks' semester basis.

The development team was in charge of creating a course that provides a first introduction to the *understanding* of technologies (as basis for further courses in Informatics) and at the same time provides fluency with common office automation tools, which were required in other courses.

The prior editions of the course had left available some slides and a set of readings in Spanish.

The instructional setting – namely: staff roles and persons, tools and locations – were set *a priori* by UNIVELS. They will be described in detail below.

The evaluation of all UNIVELS courses happens in two stages: a first grade is given at mid-semester (with a value of 35% the final grade); a second grade at the end of the course (65%). The instructors can set the type of evaluation (oral, written, projects, etc.).

### Issues

The design of *Teleinformàtica I* had to cope with the following issues:

1. An inhomogeneous and untested entry level for the students. As it emerged during the course, this was:
  - a. Very low for the greatest part of students, that came from a disadvantaged group of the population. Some issues were poor reading and writing abilities, low math and formal reasoning abilities, no foreign language, and poor general cultural background.
  - b. Quite high for a few students, that had come to Eurocol looking for European-style education.

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<sup>1</sup> The pedagogical structure of UNIVELS distance learning courses is protected by a worldwide intellectual property patent.

2. Language issues: while the instructors were all Italians, all tutors and students were Spanish-speaking Latin American, with low knowledge of English or other languages.
3. Cultural issues: formal education is performed in a much different way in Italy and in Colombia. Moreover, all cultural references are different.
4. The novelty of the unprecedented delivery system for the instructors.
5. The challenges of staff communication (tutor-instructors), which had to overcome language, culture and intercontinental distance.

Moreover, the design started only two months prior to the beginning of the course.

As already said, the course setting was centrally defined: every course at UNIVELS can count on:

- The instructor (who is at the same time the designer in most cases). Eventually more instructors can collaborate in developing and teaching the course. This was the case *Teleinformàtica I*, where three instructors collaborated.
- Five tutors, one for each geographical group of students (called node).
- At each node, a videoconference classroom, a computer lab and spaces for personal and group study.
- The videoconferencing system.
- The asynchronous learning platform.

### *Proposed Solutions*

In order to tackle the issues above, the design team proposed the following points:

1. Reduce the number of lectures and focus on learning-by-doing as more appropriate to the profile of learners. This meant turning the standard UNIVELS course week into two different modalities: lecturing and project.
2. Language issues:
  - a. Use a translator for lecturing, but learn a little Spanish in order to enhance “direct” communication (although in videoconference).
  - b. Provide all materials in Spanish, with only few cases in English for stimulating learning the language (students also had an English course).
3. Enhance staff communication with a formal protocol.
4. Provide precise method and organization guidelines in order to make clear what the instructors expect (in order to fill cultural gaps concerning formal education such as lecture attendance).

## **Design**

### *Design Structure*

The design solution was basically structured in three parts:

1. A first set of videoconference lectures for introducing the main topics and the basic concepts, along with indications for personal work and readings. The main topics were: the Internet and its functioning (client-server, protocols, etc.), computer architecture, and digital information formats.
2. A second set of videoconference lectures for presenting office automation applications along with exercises for practice. The applications selected (on requests by instructors of other courses and of the central coordination of UNIVELS) were Microsoft Word, Excel and PowerPoint.
3. A group work covering 5 weeks where all major concepts presented were rehearsed and where all the applications were used. The topic for the group work (called *taller*, i.e. atelier) was set to be information retrieval in the Web.
4. The definition of a formal procedure of communication with tutors.

### *The Design Process*

The development of the main course outline and the topic selection was conceived together by the 3 instructors. One of the instructors assumed the role of main designer.

The work was then split as follows:

- One instructor prepared the introductory lecture (which was given together with the students of the 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> semester).
- The second instructor prepared concept lectures, readings and the *taller* activity. This instructor was also in charge of designing and conducting the evaluation (partial exam, as 35% of the final grade, and final project assessment, as the remaining 65%).
- The third instructor prepared lectures and exercises for office automation.

All slides and materials were reviewed by the instructors, and uploaded to the platform by one of them.

#### *Role of E<sup>2</sup>ML*

The instructor-designer mastered E<sup>2</sup>ML and used it for sketching the general course outline to be discussed by the team.

He then used it to develop the details of the concept lectures and of the *taller*, for which he was in charge. He used the detailed action diagrams as roadmap for the lectures during the course, and for keeping track of the taller activity by adding notes to them as the course proceeded.

### **Goal Definition**

The definition of the goals for *Teleinformàtica I* consisted in a refinement of the assignment given by UNIVELS to the designers. The instructors did this using QUAIL. A committee by UNIVELS reviewed the final statements for approval.

A goal concerning teamwork was added (G5, which was one of the reason for the definition of the *taller*) on request of the UNIVELS committee, who viewed it as a key competence both for effective learning and for the students' future professional life.

#### *Goal Statement*

GOAL STATEMENT						
TAG	STATEMENT	TARGET	STAKEHOLDER	APPROACH	ASSESSMENT	IMP
G1	Think of new technologies as necessary tools for personal productivity and entrepreneurial activity (attitude)	All students	UNIVELS, other instructors, Instructors	Activity	Discussion + taller	4
G2	Basic concepts of computer science and networking: Computer, RAM, I/O, ..., Server, client, network, ...	All students	Instructors	Explanation and examples	Written exam (questions)	4
G3	Basic use of MS Office Automation applications Basic use of MS Word (write letter, CV) Basic use of MS Excel (simple accounting an reporting with graphs) Basic use of MS PowerPoint (presentation)	All students	Instructors, students	Demonst + exercises	Reports + Taller	3
G4	Plan, organize and conduct an effective search in the Internet Use the Web and the browser Use search engines Filter results by relevance and quality	All students	Instructors	Project-based group work	Taller	4
G5	Structure and conduct a project team work Express objectives Organize resources and tools Assign and control tasks Evaluate results	All students	UNIVELS, Instructors	Project-based group work	Taller	5

Table 4.4.1 – Teleinformàtica I: goal statement

## Goal Mapping

The goal mapping reveals the particular understanding and interpretation of the goals that the instructors had.

Notice that G2, a concept goal, is in the *remember* scope: the course does not want students to apply all concepts (they are not computer scientists), but only to remember them. The following courses (Teleinformatica II and III) will provide a chance to brush them up and to apply them to real situations. The concept of *client-server* was for instance introduced here, but was seen in practice only in Teleinformatica II, where Web development was the main topic. Notice also that G4 (Web search procedures) is on the *reflection* level: the goal here is not only to perform some procedures, but also to critically evaluate them – or at least asking the question: “does it work?” or “Is it the best way to do it?” Finally, G3 and G5 (both complex goals) are on the *insight* level: students were not asked to achieve a clear conceptual understanding of office application or of team working (e.g. a sort of theory of team working), but to solve some tasks and to organize a specific team for a specific goal. G1 is the only goal on the *action* level, and concerns a general attitude toward IT.

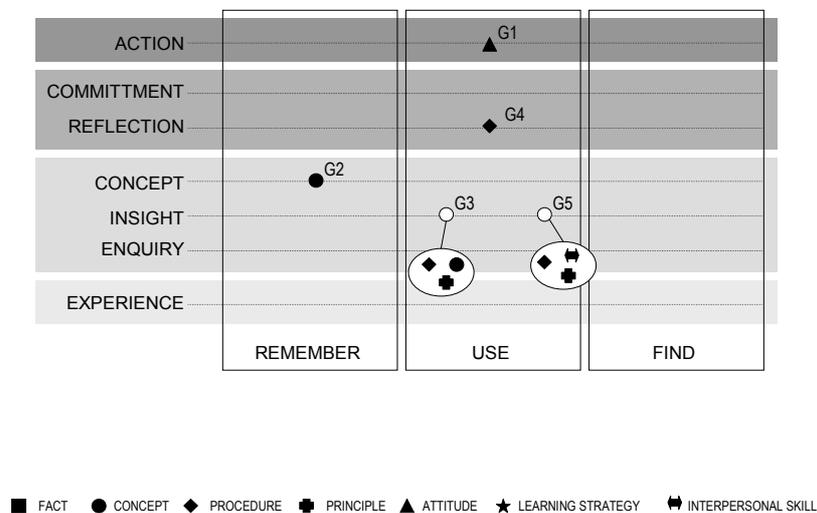


Figure 4.4.1 – Teleinformatica I: goal mapping

In the following description of the course design, we will start with resources, as they were defined by the standard UNIVELS setting.

## Resource Lists

### Role & Actor List

The role and actor list shows tutors and students in the five nodes (geographical groupings). Under each role the main language spoken is reported.

Notice the technical support role, provided centrally by UNIVELS, and the translator, actually a support role, yet necessary in this situation (and also relevant from the budget point of view). The names are blinded.

ROLES					
TAG	ROLE NAME	TYPE	DESCRIPTION	#	ACTORS
I	Instructor (Italian)	STAFF	Holds the online lecture, guides exercises. Manages the online platform. Is responsible for the course	3	Lorenzo Barni, Chiara Rossi, Gianni Fioravanti

T	Tutor (Spanish)	STAFF	Helps students daily with organizing the work, the groups, interacting with I and A	5	One for each node: - Wilmar Castro (Bogotá 4) - Sandra Robayo (Bogotá 2) - Fabián García (Armenia) - Myriam Marin (Cartago) - Mario Agudelo (Pereira)
S	Student (Spanish)	LEARNING	Student	50	Freshmen. For each node - Bogotá 4 (9) - Bogotá 2 (15) - Armenia (12) - Cartago (3) - Pereira (11)
E	Evaluator (Italian)	STAFF	Evaluates exams	1	Lorenzo Barni
TS	Technical support (Italian / Spanish)	STAFF	Provides technical with the videoconferencing environment + platform	2	Marco Ceriani (Milano), Julian Marin (Bogotá)
TR	Translator (Italian / Spanish)	STAFF	Translate course materials + simultaneously lectures	1	Ana José

Table 4.4.2 – Teleinformàtica I: role & actor list

### Location List

The location list reports the basic functional structure of each node along with the transmission location for the instructor (the usual locations: videoconference lectures could be held from virtually any place with an Internet connection).

LOCATIONS			
TAG	NAME	DESCRIPTION	FACILITIES
SL	Salòn de clase	Classroom equipped for IP-based videoconference (in each node)	PC, LAN Internet connection, 1 microphone, PC audio output, beamer. 50 places
SE	Salòn de estudio	Room with 20-30 places (free access, in each node)	Tables and chairs
SC	Salòn de computo	Room with 20-30 workstations (free access, in each node)	About 20 fully equipped PCs, LAN Internet connection
T	Transmission	The Instructor's transmission location	Any location with a PC with minimal requirements for the videoconferencing environment

Table 4.4.3 – Teleinformàtica I: location list

### Tool List

The following tool list marks with a \* the tools that were provided by UNIVELS. The instructors developed all others especially for the course.

Notice that:

- In order to facilitate the *taller* work, examples of well-done products of the activities were included.
- In order to provide a reference, a Spanish book was adopted.
- A specific tool for feedback and reporting was developed for enhancing tutor-instructor communication.

TOOLS						
TAG	NAME	CLASS	DESCRIPTION	AVAILABILITY	MAN.	SUP.
PL	Online platform*	SERVICE	Elearning platform for lecture materials, forum, chat (Studio+ PDL)	Available on a server in Italy. Access: only a browser ( <a href="http://www.univels-eurocol.com">www.univels-eurocol.com</a> )	TS + I (for material upload)	TS

VC	Videoconferencing environment*	TOOL	Complete videoconference: audio, video, slides, browsing together, marking tools, etc... (Centra Symposium)	Available on a server in Italy. NOTICE: version 6, not compatible with 5!	TS	TS
S	Lecture slides	CONTENT	PPT for the lecture, PDF for uploading on the platform. Slides are a different bundle for each lecture week.	During the lecture, on the platform for personal study	I	-
EX	Exercise descriptions	CONTENT	Guidelines for exercises (PDF)	On the platform	I	-
OP	Optional materials	CONTENT	Articles, links	On the platform	I	-
RB	Reference Book	CONTENT	P. Norton, <i>Introducció a la Computació</i> , MC Graw-Hill, III ed.	Available to students in the nodes	-	-
T	Taller contract	GUIDELINE	Detailed guidelines for TALLER	On the platform (PDF)	I	-
TEX	Taller examples	GUIDELINE	Examples of well-solved taller activities	On the platform	I	-
REP-C	Report: class	TOOL	Excel form for observing and reporting class attendance to lectures.	Via email	I	I
REP-S	Report: student	TOOL	Excel form for annotating event and remarks on single students.	Via email	I	I

Table 4.4.4 – Teleinformàtica I: tool list

## Overview Diagrams

### *Dependencies Diagram*

The dependencies diagram was built following the general design structure indicated above. The first step in designing the course was in fact dividing weeks in *lecture* and *taller* weeks. Each box in Figure 4.4.2 containing a W tag represents a weekly module, i.e. all the activities performed in one of the 16 weeks of the course (notice that there is no WL8 – the exam took place in fact in week 8). Some of them were used as lectures (WL), others for the *taller* (WT).

Lectures were then divided in three groups: the first introducing basic concepts, the second dealing with office automation applications, and the third presenting information retrieval on the Web. This last group was given autonomy as its topic directly addresses the work of the *taller*. Notice that while trails were used in Istituzioni 3 for grouping actions according to their delivery mode, here the grouping criterion is content.

The *taller* was then organized in a flow of five weeks – where the great effort is concentrated in WT15, as one can infer from the great number of incoming prerequisite arrows. In short, the *taller* weeks were organized as follows (details are provided in the action diagrams):

- WT12 – perform a first search; write a first relevant site list.
- WT13 – refine the search; write a final relevant site list (report 1).
- WT14 – focus on teamwork; write a report describing how the group was organized (report 2).
- WT15 – further optimize the search; write a summary of results (report 3).
- WT16 – final discussion and conclusion.

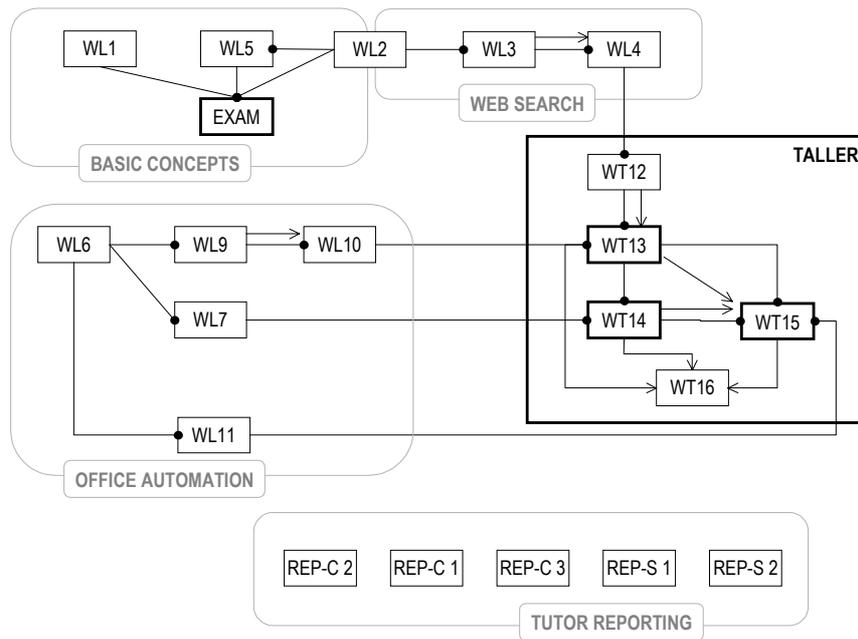


Figure 4.4.2 Teleinformàtica I: dependencies diagram

The diagram clearly shows the great consistency of the course, despite the three different kinds of activities: prerequisite arrows connect in fact all the activities with each other, having a focus in the taller.

Notice that the EXAM activity, which represents the mid-semester exam (35% of the final grade), only concerns the basic concepts. This was done in order to have a specific place where to test theory (as different from the practice in searching the Web and in using applications, which was tested in the taller). The concepts tested in that exam are not included as prerequisite for the taller, and cannot therefore be assessed through that activity. There is no final exam as the second grade (65%) is an evaluation of the overall taller activity.

The REP boxes represent support activities, namely the definition of the communication protocol between tutors and instructors. It consisted in a continuous observation of classes, which produced annotations in a standard form, which was to be sent per email to the instructor. This would eventually generate requests for comments or videoconference meetings for discussion. Details will be given below.

#### *Activity Flow*

The activity flow is very straightforward: it shows the sequence of modules (one each week) and the synchronization of communication events between tutors and instructors.

The streamlined nature of the flow corresponds to the necessity, expressed by UNIVELS, of offering a strong guidance to students who were not able to organize their own work effectively, given their poor experience of study. This was done minimizing student choice and providing full guidance. The only exception was the group organization of the taller. Notice that in order to improve legibility, period arrows have not been drawn: actually, each weekly module is an activity that should be completed within the week.

Notice also that the evaluation elements are produced in the exam and in the three central weeks of the taller.

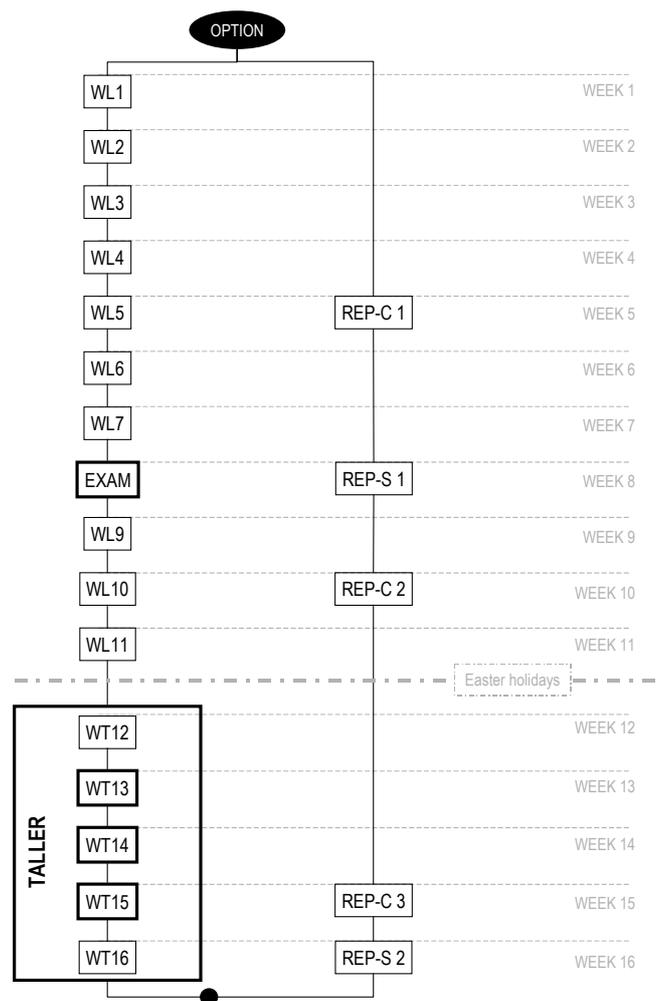


Figure 4.4.3 – Teleinformàtica I: activity flow

Given its simple nature, the activity flow was used for scheduling activities in the course, but was not used during the course. For the same reason, the CBS was not developed.

### Action Diagrams

The design basically relies on the adaptation of the standard modular structure to different activities. E<sup>2</sup>ML Advanced Version was a powerful support to this process thanks to the definition of action types and inheritances.

The basic weekly module (modeled as a type action) is composed by a class session (in videoconference), a weekly personal work by the students, who are advised to work in groups, and a reporting activity for the tutor, which consists in filling in the report form.

The class session exploits the transmission locations and involves all roles. It requires the videoconferencing system and the slides for that week. The weekly work is based on online materials collected in the platform, and may eventually exploit the forum. The reporting activity uses the report form, which was prepared by one instructor.

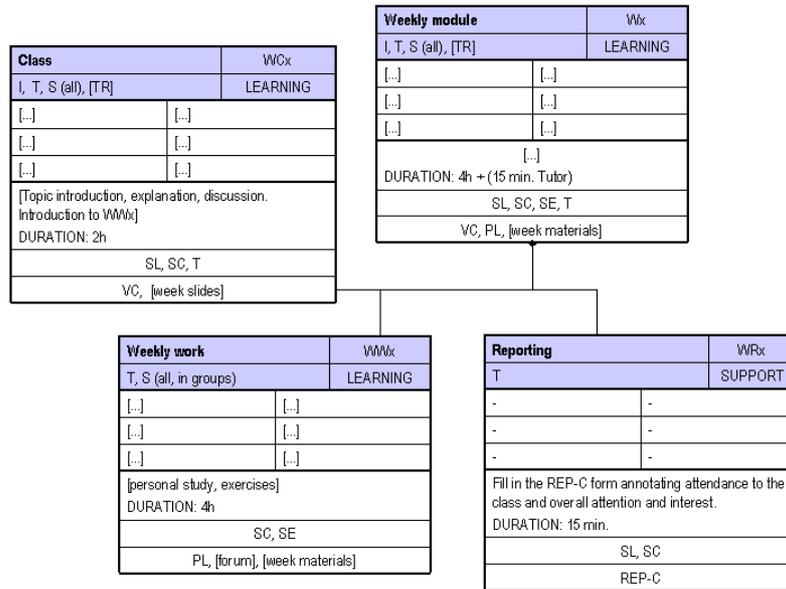


Figure 4.4.4 – Teleinformàtica I: basic module (action diagrams)

This basic structure was inherited by two subtype-actions: one for lecturing (WLx - which included concept lectures and office automation introductory sessions) and one for the *taller* activity (WTx), as shown in the Figure below.

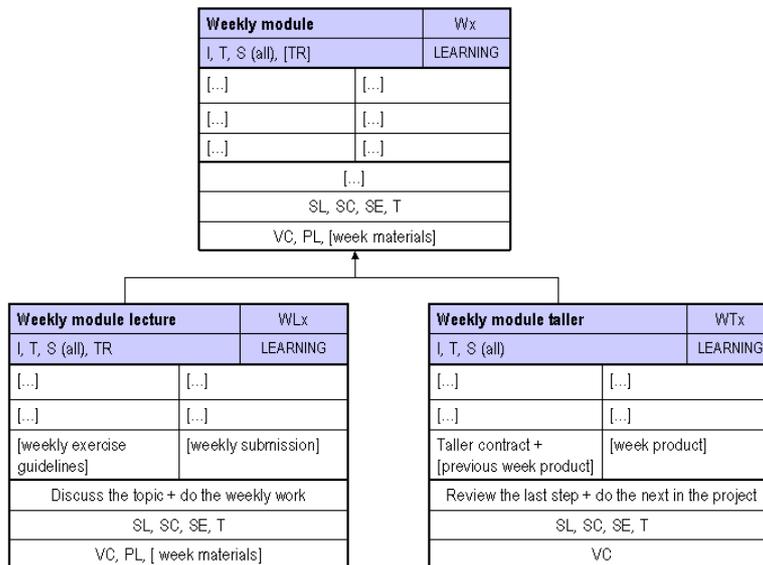


Figure 4.4.5 – Teleinformàtica I: basic module inheritances (action diagrams)

The details of the inheritances are provided in two diagrams. The one for lecture modules (Figure 4.4.6) shows that no modification was introduced in the original structure. More specific procedure guidelines are indicated in the *lecture* (the class session).

One example of an instance of the weekly module for lecture weeks is reported in Figure 4.4.7 (other modules are not reported here). It addresses the G2 goal, and deals with computer architecture. Moreover, the lecture provided an introduction to the history of computing, which was the main topic for the weekly work (the reporting action was omitted).

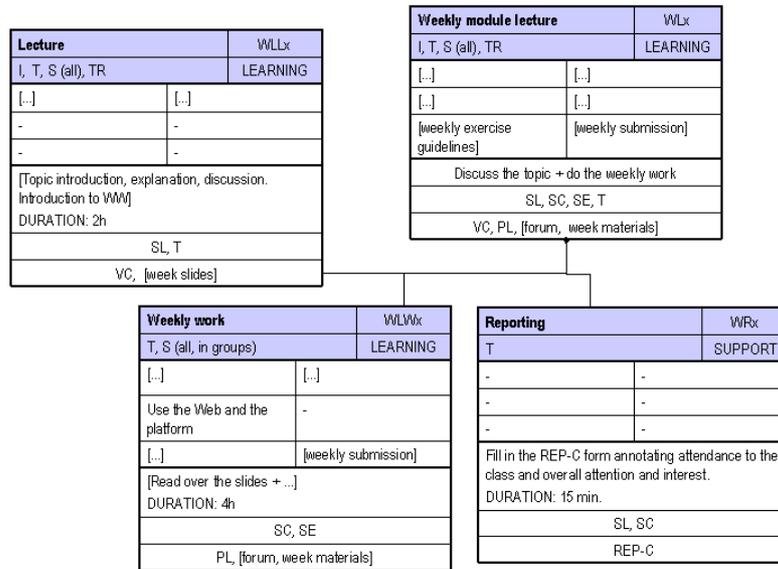


Figure 4.4.6 – Teleinformàtica I: basic module for lecture weeks (action diagrams)

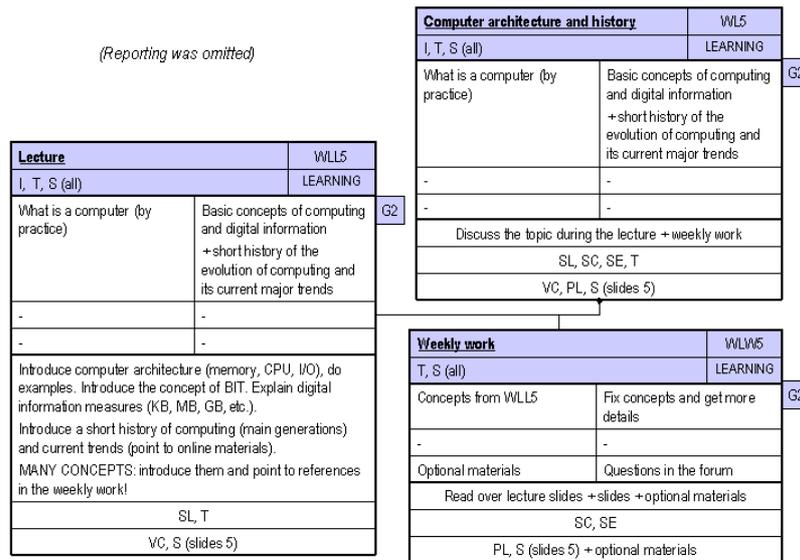


Figure 4.4.7 – Teleinformàtica I: lecture week instance (action diagrams)

The *taller* weekly module (Figure 4.4.8), on the other hand, required some extensions with respect to the general module. The class session was turned into a review, where the work done in the previous week was commented and the task for the current week introduced. The weekly work, to be performed in groups, was not studying, but completing some assignment. Assignments were submitted and corrected by the instructor – in a specific sub-action defined only for taller modules. The reporting action had remained unchanged.

An example of taller week is shown in Figure 4.4.9. It is week 15, where the final report (report 3) is being produced. The videoconference review provided feedback about report 2 (from the previous week) and guidance for report 3, which is to be done with PowerPoint (addressing goal G3) during the weekly work (the *correction* and *reporting* actions were omitted for reasons of space). Notice the presence of the T tool, i.e. the *taller contract*, which specified the work to be accomplished each week.

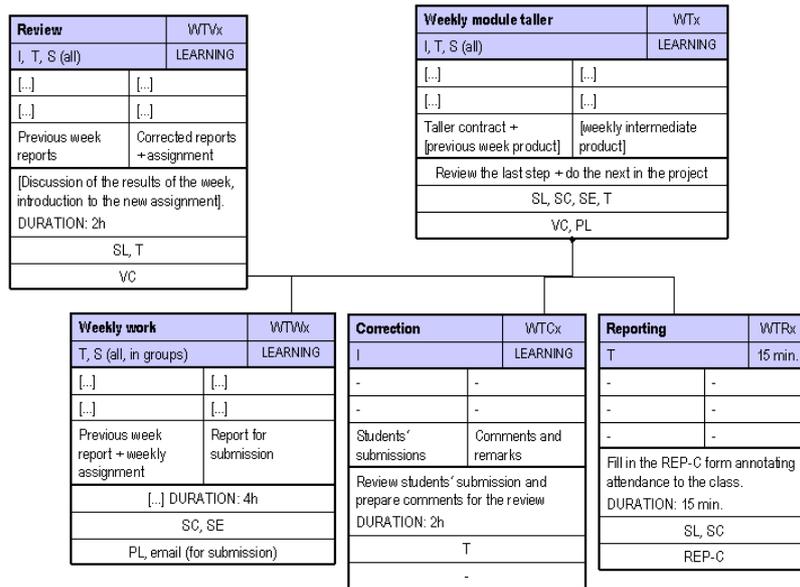


Figure 4.4.8 – Teleinformàtica I: basic module for the taller (action diagrams)

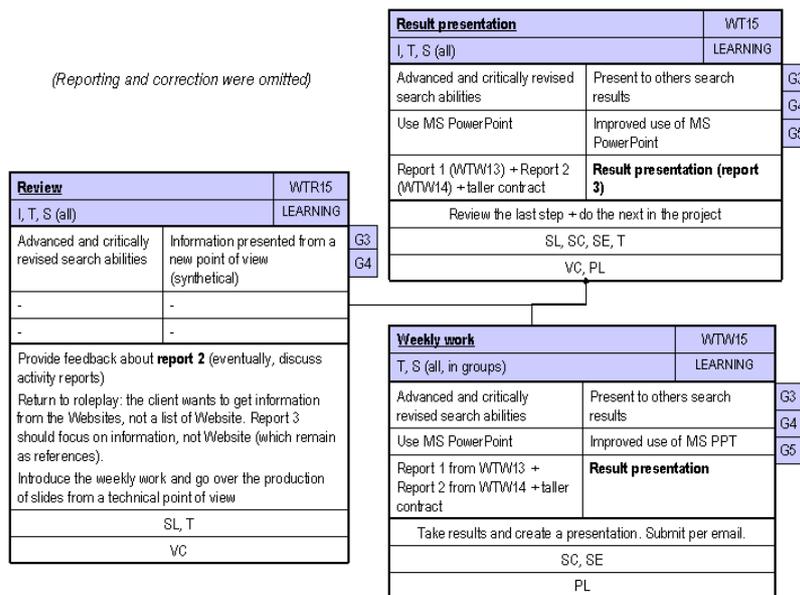


Figure 4.4.9 – Teleinformàtica I: taller week instance (action diagrams)

The *taller* as a whole activity was then described in a super-action (Figure 4.4.10) that included the five weekly modules. Its action diagram specifies its goals and general strategy: learning-by-doing in a sort of role-playing context.

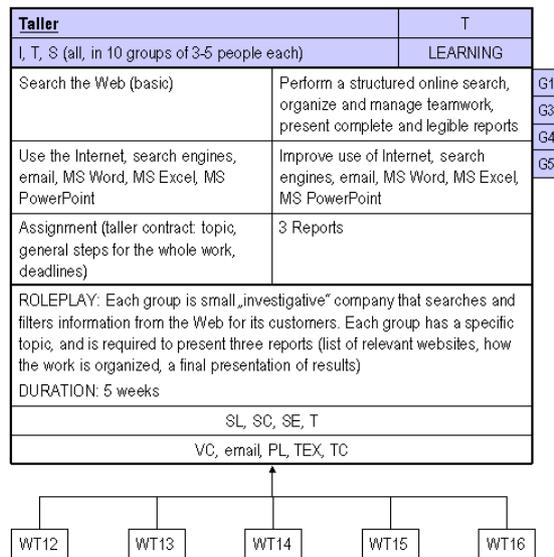


Figure 4.4.10 - Teleinformàtica: the taller (action diagrams)

The partial exam, which took place before the taller, was described as follows:

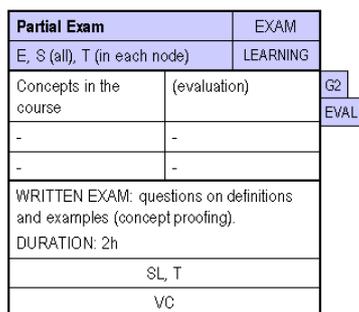


Figure 4.4.11 - Teleinformàtica: mid-semester exam (action diagrams)

Finally, the reporting activity was described through two representations:

1. The reporting component in each weekly module.
2. Two action types, which were used for defining the moments in which tutors were asked to make a summary of their evaluation and send them to the instructors.

The two diagrams for the action types are reported below:

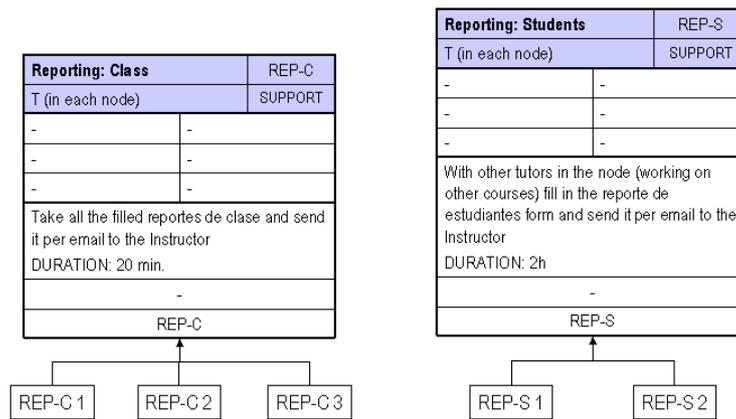


Figure 4.4.12 - Teleinformàtica: reporting activities (action diagrams)

## Outcomes

Teleinformàtica I was pedagogically a success for UNIVELS and Eurocol. Its precise design, which considered the standard weekly module as a flexible container to be adapted to different situations (lecturing and learning-by-doing) proved to be effective.

In particular two features of the course were appreciated:

1. The reporting activity: E<sup>2</sup>ML allowed the integration of support activities in the course structure, thus tackling the issue of staff communication. This was important as tutors, being in a face-to-face situation, are the only source of direct feedback in this setting, and losing their contribution would have meant losing the greatest chance of fine-tuning the course. This reporting modality, which was developed after a testing run in the previous semester<sup>2</sup>, is likely to be extended to other courses at UNIVELS.
2. Working with E<sup>2</sup>ML dependencies diagram allowed a more conscious definition of the mid-semester exam and of the taller in such a complex situation, avoiding overlapping and enhancing integration. This also freed the final evaluation from external elements. The result was an exam focused on definitions and examples, which revealed some problematic cognitive dynamics in a large number of students, the most due to their low entry level, e.g. difficulties in abstraction, low mastery of technical terms (which proved to be issues also for other courses). Conceived that way, the exam turned out to be an instrument for improving the instructional strategy, eventually for identifying extra-course activities addressing learning strategies.

## Points of Interest

The modeling for Teleinformàtica I provides a good example of the expressive power of E<sup>2</sup>ML for modular structures, which are widely used in Higher Education. This was done exploiting inheritances and aggregations, features of the Advanced Version, and remodeling the basic module in two different versions. E<sup>2</sup>ML also proves once more its flexibility coping with an unusual delivery system, such as videoconference lectures.

E<sup>2</sup>ML was useful to the instructors under two respects:

1. The dependencies diagram was here used as a synthetic representation for keeping the overall consistency of the instruction.
2. The action diagrams were used as diary during the course, for keeping track of the class advancements and problems.

<sup>2</sup> The first structured observation method was set up by Elisabetta Paglia in 2002.

Moreover, the QUAIL model was here useful to precisely focus the learning goals for the course, namely distinguishing between the *concept* and *insight* levels.

Leaving aside technical considerations, this case study presents a somehow original situation, a sort of “intercontinental videoconferencing lecturing”, which is likely to become a usual scenario in the next few years. I personally believe that providing access to education to the population of poor and rural areas is one of the main missions and challenges for the eLearning community.

## LOGICA @ USI, Lugano

<b>Institution</b>	University of Lugano, Faculty of Communication Sciences (Switzerland)
<b>Design situation</b>	Redesign from a lecture-based course
<b>Topic</b>	Formal logics
<b>Delivery type</b>	Face-to-face + online activity
<b>E<sup>2</sup>ML version</b>	Advanced
<b>Role of E<sup>2</sup>ML</b>	Design + development
<b>Abstract</b>	This course was restructured according to four issues emerged in the previous semesters: a mixed audience, the difficulty to understand the subject matter, the hurdles posed by formal expression to some students and its position within the curriculum. The design team proposed the development of a partially online group activity.

### The Course

*Logica* is a course in formal Logics delivered within the curriculum of Communication Sciences at the Università della Svizzera italiana in Lugano.

The curriculum develops into four specializations: mass media and new media, corporate communication, communication technologies and communication and education. All students enrolled in the technology specialization (or 3<sup>rd</sup> specialization, about 30 students each year) must take *Logica*, while it is elective for others. Along with them, some students from the Faculty of Theology (about 10) and from that of Economics (about 3) usually enroll. For Winter Semester 2003<sup>1</sup>, also students from the mass media specialization (or 1<sup>st</sup> specialization) will attend the course (about 20).

The course takes 56 hours distributed as 2 meetings of 2 hours each week in a 14 weeks' semester. The original format was basically a set of frontal lectures mixed with exercises solved together with the instructor. At mid-semester students may choose to take a written examination covering the content of the first part of the course; if they do, they will not be tested again on it. At the end of the course another written exam takes place: this covers the second half of content for students who took the first examination, or the whole course for the others. After the exam, all students have a short personal discussion with the instructor for concluding the assessment.

During the years, a set of slides was developed, along with exercises covering all the main course topics. Examples of exams of the past years were made available to students on a campus network drive along with solutions. No other support material was used.

Student assessment of the course was extremely positive as for content covered, method (also thanks to the instructor's clearness in lecturing) and evaluation.

During the last year, students from Theology took advantage of extra tutoring hours for rehearsal and practice.

### Issues

The redesign of *Logica* started identifying four main issues.

1. The first issue concerns the attendance of four different groups of students: students in Communication Technologies (labeled here S3), students in Mass Media Communication (S1), students in Economics (SE), and students in Theology (ST).
  - a. All of them have different interests and goals: formalization and modeling for S3 and partially for SE; the understanding of human language and argumentation for S1; the achievement of tools for Philosophy for ST.
  - b. Moreover, all of them have different attitudes toward formal reasoning and formulas: while they look like "punishments" to S1 and ST, they are usual tools for S3 and SE.
  - c. The main course targets are S1 and S3.
2. The second issue concerns the general learning outcomes assessed in previous editions. The instructor and the assistant verified that the great part of students just learn by heart deduction

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<sup>1</sup> The upcoming semester at the time this document is written.

rules and the solution to standard types of exercises, but did not achieve a real understanding of Logics as such. The result is that:

- a. If asked why they solved a problem in a particular way, they cannot provide any answer.
  - b. Some weeks after the exam, they do not recall what they have studied.
3. The third issue concerns the nature of the subject with respect to students in a non-technical curriculum. Students in Lugano are not used to deal with formal expressions and reasoning. The risk for them is focusing on tiny details (formula reading, the use of brackets, definitions, etc.) losing a general view of the whole subject matter as a particular form of human thinking – which is indeed the main perspective of the course. This is particularly evident when the course addresses first propositional logic and then predicative logic: students cannot distinguish them, as the formulas are similar, while they actually have different expressive power.
  4. A final issue concerns the connection of this course with other courses in the curriculum, both for those coming before Logica, and for those that students will take thereafter.

#### *Proposed Solutions*

1. Course goals were divided into general goals and group-specific goals. Specific group work was designed for group-specific goals and included in the final evaluation.
2. Students were given a more active role in a part of the course, where they are in charge, as part of a small group, to solve a problem and reporting it. This compels students to put into action what they have learnt (see issue 3).
3. The issue of general view on the whole course content was addressed by developing a map of the course along with a map of the different types of logics. These materials were handed out to students and used for introducing topics and connecting them with each other.
4. The fourth issue is a matter of curriculum design that should be addressed on a larger scale at Faculty level, and fall beyond the scope of the redesign – consequently, this issue will not be completely tackled. Nevertheless, the development of an introductory module, recalling some elements of the Math course, was developed together with the instructor of that course.

## **Design**

### *Design Structure*

The design was structured in the following points:

1. Keep the lecture-based structure, which provides the professor with the chance to discuss difficult concepts and to draw examples or propose exercises at the right time.
2. Develop a group activity to let learners switch to an active role in the course.
3. Differentiate the group activity according to goals peculiar each group of students.

### *The Design Process*

The redesign activity for Logica was initiated by the professor teaching the course, and was conducted with the support of the assistant and one instructional designer.

The curriculum definition of the Faculty provided the general requirements for the course. The redesign started identifying the issues stated above, both from the professor's experience and from the feedback collected in the previous semester.

Given the standard situation of an undergraduate course and the detailed knowledge of the context of all team members (all of them had worked in the Faculty since at least 4 years), no formal analysis phase was necessary.

The whole redesign process lasted three months, and could be split into two phases:

1. Phase 1: A regular meeting was held weekly during the first 6 weeks, and the overall design was achieved there (goals and main course outline).
2. Phase 2: After phase 1, the development was split between the designer (in charge of developing all materials except slides and exercises) and the assistant (in charge of developing slides and exercises). In this second part, the professor acted mainly as a reviewer.

The complete design of activities was carried out in phase 2. Notice that slides were in their fourth edition, and required therefore few changes in terms of topics covered.

### Role of E<sup>2</sup>ML

The designer mastered E<sup>2</sup>ML and used it during phase 1 with the following goals:

1. Enhancing communication in the design team during the discussions: E<sup>2</sup>ML documentation provided a local indexical reference, i.e. a place on which team members could indicate a spot and say “I’d change that this way”;
2. Improving memory, inasmuch E<sup>2</sup>ML documents were used to record the status after each meeting and were used as starting point in the next one;
3. Supporting asynchronous reviews, which were done by email, commenting the E<sup>2</sup>ML documents.

During phase 2, the final documentation describing the course was then used for the development of learning materials and for checking the implementation status.

### Goal Definition

Goals for the *Logica* course are defined on different levels. Some of them are proper high-level goals (e.g. G2 or G3), while others are specified to a greater detail level (e.g. G1). This partially reflects the nature of the subject matter, which requires some general attitudes along with precise and specific concepts. The definition of goals was done by the professor, the assistant and the designer, and started with a brainstorming session, about the topics addressed in the course (as presented in the slide sets). They were then formulated in a more structured way and discussed in a second session. The use of QUAIL supported this second session and helped defining the nature, level and scope of each goal. This was in turn a support in determining instructional strategies.

### Goal Statement

GOAL STATEMENT						
TAG	STATEMENT	TARGET	STAKEHOLDER	APPROACH	ASSESSMENT	IMP.
G1	Define the term <i>Logics</i> Define <i>syntax</i> Define <i>semantic</i> Define <i>automatic deduction</i> Define <i>object language</i> Define <i>meta-language</i> Define <i>computation (calculus)</i>	All	Instructor	Definitions	Written exam (definitions)	5
G2	Understand what is modelling Know what modeling means Appreciate the advantages of formal modeling	All	Instructor	Group work	Written exam (definitions)	3
G3	Develop a positive attitude toward formal modelling	All	Instructor	Examples	-	3
G4	Understand the meaning of logic consequence (deduction) Define <i>logic consequence</i> Define the concepts of <i>decidibility</i> , <i>argumentation</i> , <i>derived rules</i> , <i>syllogism</i> , <i>paradox</i>	All	Instructor	Examples	Written exam (definitions + exercises)	5
G5	Define <i>predicative logic</i>	All	Instructor	Definitions	Written exam (definitions + exercises)	5
G6	Check a formal reasoning with natural deduction for predicative logic Be able to read formal expressions	All	Instructor	Exercises	Written exam (exercises)	4

G7	Know, define and distinguish different types of logics	All	Instructor	Definitions + examples	Written exam (exercises)	3
G8	Know, define and distinguish different types of automatic deduction	All	Instructor	Definitions + examples	Written exam (exercises)	3
G9	Understand and identify in simple real cases of human argumentation (in natural language) the underlying formal structure Recognize and analyze deductive rules Recognize and analyze syllogisms Recognize and analyze fallacies	S1	Instructor, responsible for the <i>media</i> track, students	Group work	Report	4
G10	Model simple situations with formal theories	S3, SE	Instructor, students	Group work	Report	4
G11	Articulate a critical judgment on the relationship between language and reality. Define and distinguish <i>object language</i> and <i>meta-language</i> Understand <i>understanding</i> (also) as know the truth conditions of a statement	ST (S1)	Instructor, students	Group work	Report	4

Table 4.5.1 - Logica: goal statement

Two other additional goals were identified, but left in the background (given the priorities):

1. Historical insights (facts and historical development of concepts, to be introduced through anecdotes)
2. Goedel's theorem and the limitation of Logics (concept), to be addressed and presented as a point of interests, with no further development in the course (eventually provide references).

Notice the specific target attribution to student sub-populations: while G1 to G8 are targeted to all students, G9 is specific for S1, G10 for S3 and SE and G11 for ST (and partially for S1).

### Goal Mapping

Goal mapping is here developed according to the QUAIL model. As already mentioned, it was also used as a tool for discussing objectives in the design team.

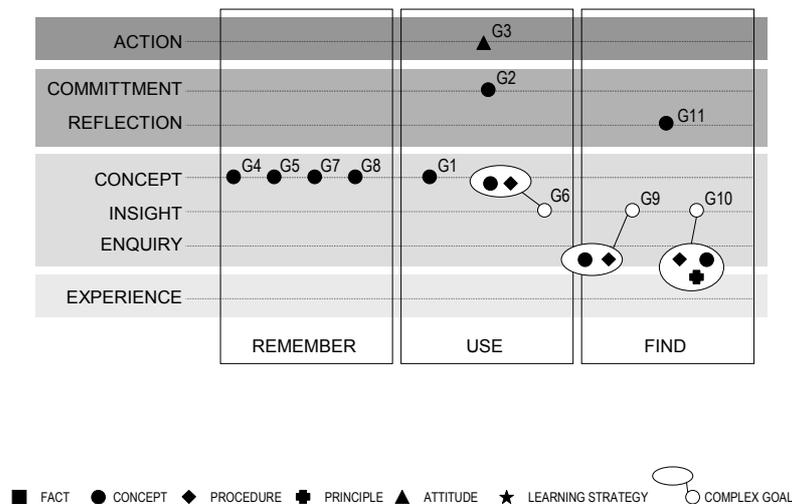


Figure 4.5.1 - Logica: goal mapping (QUAIL)

Notice the highly conceptual nature of the objectives, which is peculiar of a formal discipline as Logics. Almost all concepts are in the *remember* scope, with the exception of G2 (which is the basis for G3) and G1 (concepts necessary for G6). Also notice that G9, G10 and G11, which are specific goals for different targets, are *not* of the same type although all of them are in *find* scope. This may actually be seen as a problem in terms of evaluation, and in any case should be considered that the online activities, although exploiting the same technology and logistics, actually aim at different types of knowledge.

## Overview Diagrams

### Dependencies Diagram

Basically, Logica is composed by

1. An introduction + an entry module.
2. Lectures (L1 to L18).
3. An Online Module activity (all *M\_ actions*, OA1, OA2, REP1 and REP2).
4. Tutoring and rehearsal activities.
5. Exams.

The dependencies diagram reveals the basic structure of the course and the types of activities: lectures (or classes, as they include explanations, exercises and discussions), the online activity (in-depth), tutoring and rehearsal, along with the exams and the optional entry module. The prerequisite arrows indicate that all lectures are in a logical sequence, while rehearsals depend on the last lecture (they will actually take place at the end of the course, before the final exam – see the activity flow). The structure of the in-depth part includes the production of objects (namely, reports): this is the part of the course where students take an active part (see issue 2).

In this document lectures are not developed into a more detailed design stage. Content selection and strategies for each lecture were indeed defined by the professor during the course. This was done in order to allow him more flexibility and to the students a more seamless mix of lecturing and exercises. The designer developed the dependencies diagram after the team defined the main course outline, and was used thereafter for checking consistency between the definitions of single actions on a further level of detail.

Also notice that tutoring sessions are optional (although recommended for ST students).

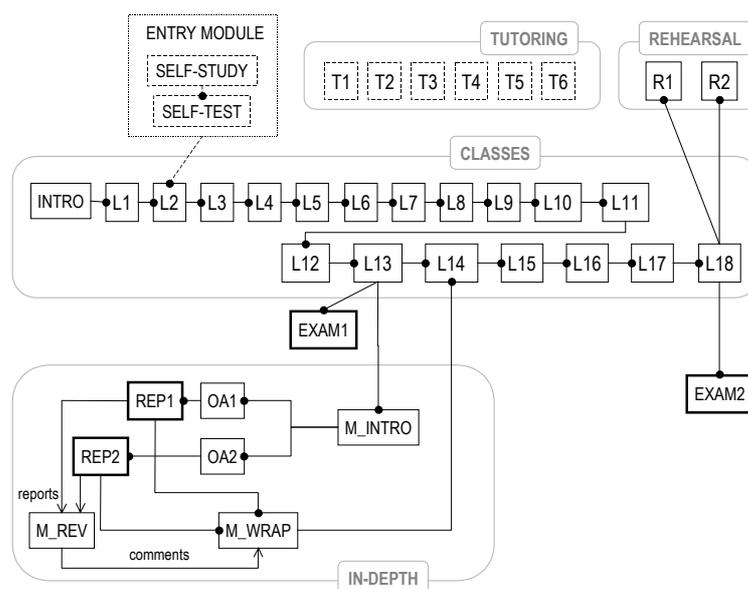


Figure 4.5.2 - Logica: dependency diagram

### Activity Flow

The activity flow represents a double track of lectures and tutoring sessions in some periods. These streams have been represented as parallel as they describe different “tracks of action” in the course.

Notice the position of the EM (ENTRY MODULE), at the beginning of the course: it is an optional action that should be completed within the first two weeks of the course.

The online activity, which takes place right after the partial exam (EXAM 1) is thought as a choice: each student may choose if taking OA1 or OA2 (the action diagrams later on reveal that these are two similar activities on different topics). A concluding wrap-up session will then collect all the outcomes of the two branches for all students. This matches with the identified solution for issue 1.

Date lines are here used only for indicating the course big phases and specific deadlines for the online activities. The rest of the lecture was actually scheduled according to the Faculty regular calendar (i.e. weekly meetings).

The activity flow was used as discussion tool during phase 1, in order to arrange activities within the constrained course timeframe.

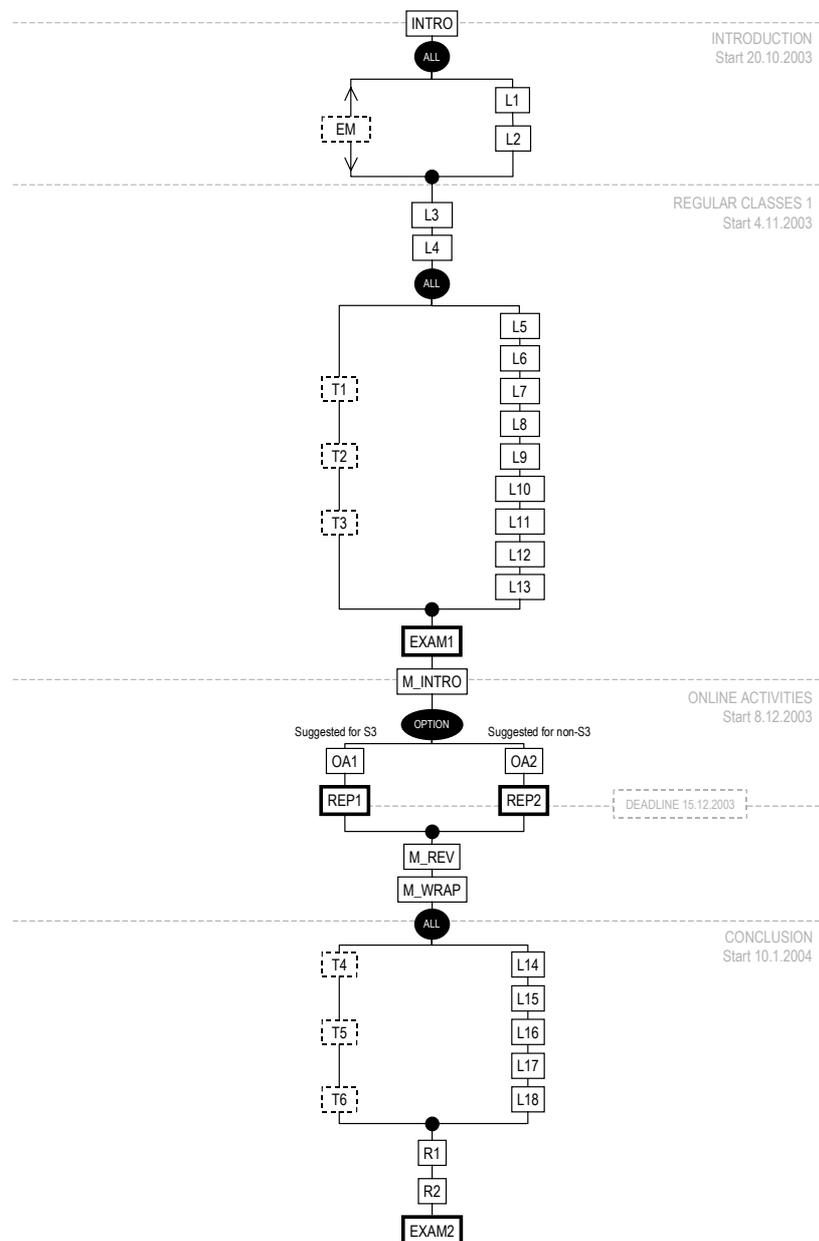


Figure 4.5.3 - Logica: activity flow

### Course Breakdown Statement

The CBS was developed after the design was completed, and was useful to keep track of the time allocated for each activity, as the time constraint in terms of learning activity was set by the administration<sup>2</sup>.

ABS						
TAG	NAME	TYPE	ROLES	LOCS	TOOLS	DUR
INTRO	Course introduction	LEARNING	L, A, S (all)	A34	MC, ML, WS, GL, OM0, [OM1, OM2]	2h
EM	Entry module	LEARNING optional	S (all, single)	Anywhere	OM0, WS	3h
L1 to L18	Lectures	LEARNING	L, S (all)	A34	MC, ML, GL, S	2h
M_INTRO	Introduction to online modules	LEARNING	L, S (all)	A34	MC, WS, OM1, OM2	2h
M_REV	Revision	SUPPORT	L, A, E	Anywhere	OM1, OM2	4h
M_WRAP	Online module wrap-up	LEARNING	L, S (all, in groups of 3)	A34	MC, WS, OM1, OM2	2h
OA1	Online activity 1	LEARNING	S (all, in groups of 3)	Anywhere	OM1, WS	3h
OA2	Online activity 2	LEARNING	S (all, in groups of 3)	Anywhere	OM2, WS	3h
REP1	Report 1	LEARNING	S (all, in groups of 3)	Anywhere	OM1, WS	5h
REP2	Report 2	LEARNING	S (all, in groups of 3)	Anywhere	OM2, WS	5h
T1 to T6	Tutoring sessions	LEARNING optional	T, S	TBA	S	?
R1 to R4	Rehearsal session	LEARNING	L, S (all)	A34	MC, ML, GL, S	2h
EXAM1	Mid-term exam (written)	LEARNING	A, S (all)	TBA	(Exam text)	2h
EXAM2	Final exam (written)	LEARNING	A, S (all)	TBA	(Exam text)	2h

Table 4.5.2 - Logica: ABS

### Resource Lists

The resource lists for the course are reported in the following tables.

#### Roles & Actors List

The roles and actors list gives evidence to the presence of different groups of students. Notice that the names for the staff roles have been blinded.

ROLES					
TAG	ROLE NAME	TYPE	DESCRIPTION	#	ACTORS
L	Lecturer	STAFF	Holds the lectures	1	Marc Comb
A	Assistant	STAFF	Guides exercises, provides tutoring on request	1	Nicky Oven
E	Evaluator	STAFF	Evaluates the exams	1	Marc Comb
S3	Student, Communication technologies	LEARNING	Student	~20	3 <sup>rd</sup> year students in Communication Sciences, specialization in communication technologies
S1	Student, Mass media	LEARNING	Student	~30	3 <sup>rd</sup> year students in Communication Sciences, specialization in mass media communication
ST	Student, Theology	LEARNING	Student	~5	2 <sup>nd</sup> year students in Theology
SE	Student, Economics	LEARNING	Student	~2	3 <sup>rd</sup> year students in Economics

<sup>2</sup> In fact: All lectures + intro = 38 hours; Rehearsal = 8 hours; Modules = 10 hours. TOTAL: 56 hours (Excluded: T1 to T6, M\_REV, EM, EXAM1 and EXAM2, which could be calculated separately).

T	Tutor	STAFF	Provides tutoring for students with difficulties (2h/week for the last 8 weeks?)	1	Nicky Oven (charge from the Theology Faculty)
TS	Technical support	STAF	Provides support for tools	1	Luke Mug

Table 4.5.3 - Logica: Roles & Actor list

### Location List

The location lists simply describe the three main locations used in the course: the classroom, the computer lab and the open space (for discussion).

LOCATIONS				
TAG	NAME	DESCRIPTION	FACILITIES	NOTES
A34	Classroom A34	Fully-equipped classroom with 30 places	PC, LAN Internet connection, 1 microphone, PC audio output, beamer. 30 places. To be booked.	Bring transparencies + pencils
PC159	Computer lab 159	PC room with 30 places (free access)	A PC for each student (Win 2000). To be booked for classes	-
OS	Assistants' Open Space	Assistants' desks and a discussion room	-	Remember to book the discussion room when necessary

Table 4.5.4 - Logica: Location list

### Tool List

The tool list for the *Logica* course is quite extended, as it reports the tools for classes (slides and lectures) and those for the activity. All online tools are collected in the course Web site, which includes a submission facility.

TOOLS						
TAG	NAME	CLASS	DESCRIPTION	AVAILABILITY	MAN.	SUP.
B	Reference book	CONTENT	Reference book	(For each student)	L	-
ML	Map of Logics	CONTENT	Visual maps of different types of logics, according to expressive power	In class + in WS	L	TS
MC	Course map	CONTENT	Visual map of the course structure	In class + in WS	L	TS
S	Slides	CONTENT	Course slides, divided into blocks for each argument (each block includes exercises)	In class + in WS	L	A
OM1	Online module 1	CONTENT	Logical reasoning in natural language argumentation Study Sample problem Problem (adapted natural language argumentation) Report template	In WS	TS	TS
OM2	Online module 2	CONTENT	Modelling and theories Study Sample problem Problem (situation to be modeled) Report template	In WS	TS	TS

OM0	Entry module	CONTENT	Maths / formal languages Logical operators, truth tables Set theory (relationship, Cartesian product, function) Formal expression reading (algebra)	In WS DEVELOP with the MATH INSTRUCTOR	TS	TS
GL	Glossary	CONTENT	Glossary (electronic or hard copy). To be filled-in during the course by each student	Handed out in class + in WS	A	TS
COR	Corrected exercises	CONTENT	Solutions to exercises (for each S block)	In WS, in synch with S blocks	A	TS
SUB	Submission facility	TOOL	Submission facility	In WS	TS	TS
WS	Course Web site	COLLECTION	Collection of all other tools (WebCT-based)	<a href="http://www.logica.lu.unisi.ch">www.logica.lu.unisi.ch</a>	TS	TS

Table 4.5.5 - Logica: Tool list

### Action Diagrams

Action modeling for the Logica course is done both through type and instance actions. The diagrams presented in Figures 4.5.4 and 4.5.5 are *types*, i.e. they describe blueprints for actions in the instruction, to be specified from time to time. The Logica course uses three blueprints:

1. Lectures (for actions from L1 to L18).
2. Tutoring sessions (from T1 to T6).
3. Pre-exam rehearsal (from R1 and R2).

The inheritance relationship indicates what instance actions are instantiated from each type.

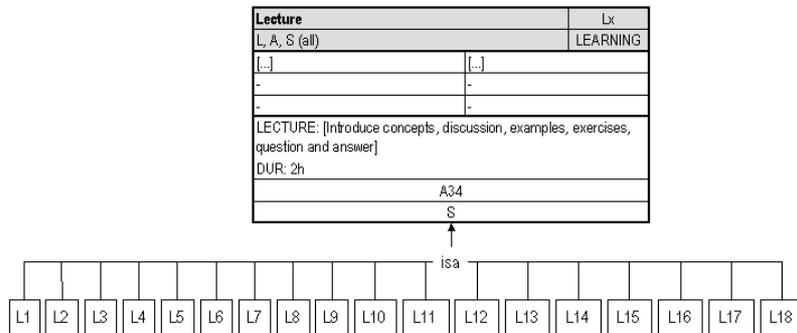


Figure 4.5.4 - Logica: lectures (action diagrams)

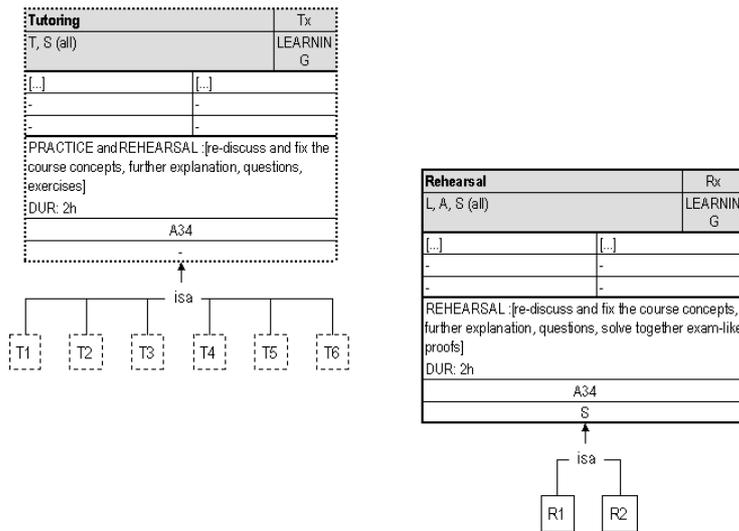


Figure 4.5.5 - Logica: tutoring sessions and rehearsal (action diagrams)

Only few activities were thoroughly modeled as instance actions, according to the needs of the situation. Others (like lectures) were left to the professor, to increase his flexibility. The course introduction is modeled as a single activity (*instance*). The same happens for the optional entry module. Notice here the use of the course map and the logic maps (which are also to be used in some lectures): they were designed for providing the course a unitary overview, thus tackling *issue 3*.

Introduction		INTRO
S (all)		LEARNING
-	Overall idea of the course, identify issues (inquiry), define Logics	G1 INFO
-	-	
-	-	
LECTURE: Introduce the course goals, its role within the curriculum, the instructional strategy, how to study, the terms of evaluations. Focus on the tools:		
<ul style="list-style-type: none"> <li>• Text book</li> <li>• Glossary</li> <li>• Course Website with the online modules (coarse-grain introduction of the activity)</li> <li>• Course map (ev. Maps of logics)</li> </ul>		
Introduce goals and functioning of OA0 (exploiting OM0)		
DUR: 2h		
A34		
B, GL, WS, MC, OM0, [ML], [OM1], [OM2]		

Figure 4.5.6 - Logica: course introduction (action diagrams)

The entry module (Figure 4.5.7) concerns some basic Math prerequisites for the whole course. It was developed with the professor of Math in the same Faculty, as an initial answer to issue 4.

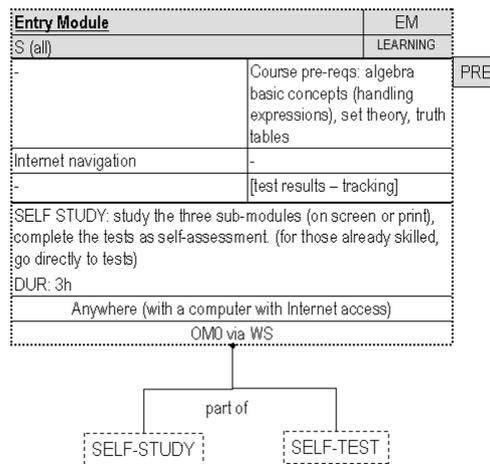


Figure 4.5.7 - Logica: entry module (action diagrams)

The online activity is the place where students take an active part of the course, and this should enhance their real understanding (see issue 2). Moreover, each student can select one topic among those offered, in order to provide the possibility to pursue one's interests (see issue 1). The activity is modeled as:

1. The introduction (Figure 4.5.8).
2. The activities to be performed by the learners, on two parallel topic-tracks (the actual Online Activity – OA – and the writing of the report – REP –; see Figure 4.5.9).
3. The wrap-up, preceded by a revision of the reports by the instructor (Figure 4.5.10).

Online modules introduction		M_INTRO
S (all)		LEARNING
Previous lectures concepts	Awareness and beginner understanding of the topics of the online activity, of its method and evaluation	G9 G10 INFO
-	-	
-	-	
LECTURE: introduce the online activity in relationship with the cours goals. Introduce the general guidelines for the two topics to the whole class, pose open issues to lead the activity. Explain the functioning of the online modules (show them online) and the criteria for selecting which one to perform (specialization track, interest). Provide indications for the definition of groups. Explain the assessment criteria and the role in the overall evaluation. Focus on the expected outcome of the work (report)		
DUR: 2h		
A34		
OM1, OM2, accessible via WS		

Figure 4.5.8 - Logica: introduction to the online modules (action diagrams)

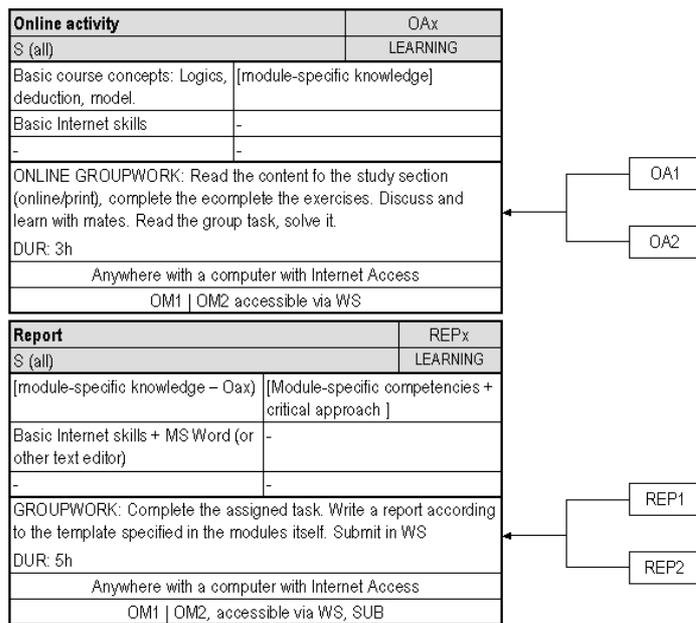


Figure 4.5.9 - Logica: online & reporting activity (action diagrams)

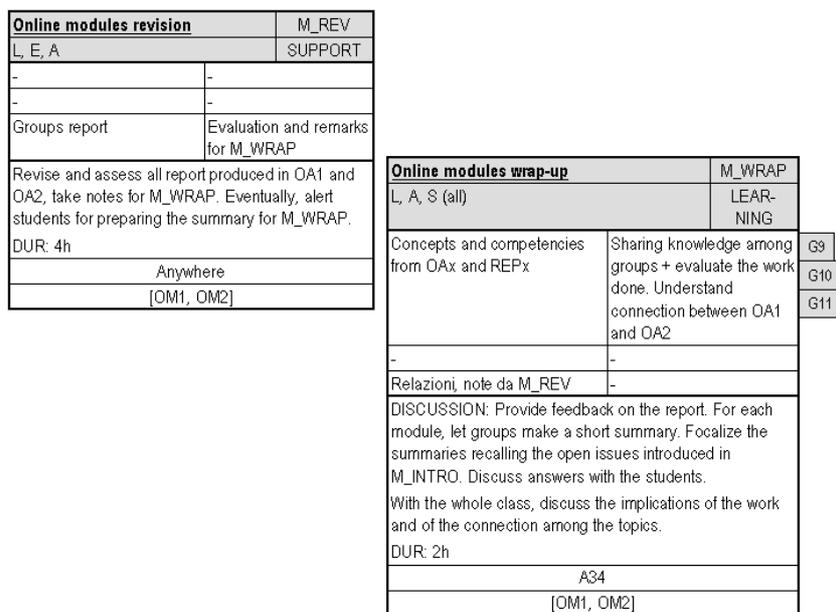


Figure 4.5.10 - Logica: revision and conclusion of the online activity (action diagrams)

Online activities and report activities actually address the population-specific goals. OA1 and REP1 address G9 and OA2 and REP2 address G10 respectively. No action addressed G11 in the same way, although it was planned in the beginning. Time constraints limited the development of a third online and report activity, and G11 was left out, given the low priority of ST with respect to whole course, and their unknown (anyway, expected very low) number.

## **Outcomes**

The redesigned Logica will run for the first time in Winter Semester 2003/2004 at the University of Lugano, and outcomes will be observable only on that occasion.

From the point of view of design, this course was a first attempt, in the context of that Faculty, to achieve an explicit process of collaborative design, and to integrate different competencies in one team working on a course. E<sup>2</sup>ML proved to be a useful support in coordinating the team and providing stable reference to continuity among the discussion and design sessions.

## **Points of Interest**

This design offers a case in which more traditional weekly classroom activity mingles with a blended learning formula of online group activity. E<sup>2</sup>ML seamlessly represents both of them enhancing the integration of the two modes.

The design was not conducted to the utmost detail. Overview diagrams were used to convey the overall structure and rationale of the course, while action diagrams were developed only for particular actions. Interestingly, lectures were not modeled in detail: the design team relied on the experience and competence of the professor for them. Any effort for further detail here would be a waste: an experienced lecturer knows how to sequence the content, how much time to devote to each concept, when inserting an example or an exercise. Moreover, this flexibility makes the design process smoother in cases like the present one, where the professor was not used to work with a designer. This is indeed an example of sensible exploitation of E<sup>2</sup>ML, tailored to the needs of the specific environment.

The real point for achieving a satisfactory consistency of the overall instruction is checking that interfaces between lectures and other designed parts are effective; the discussion about learning goals and about the overall structure of the course was a warrant for that.

## Pedagogical Patterns

### What are Pedagogical Patterns?

*Each pattern describes a problem that occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice.*

(Alexander, Ishikawa & Silverstein 1977)

Patterns are predefined potential solutions to recurrent design problems. Design patterns were first defined in (Alexander, Ishikawa & Silverstein 1977) for architecture, and were then reprised by several authors in other design disciplines, such as cognitive science (Martin, Rodden, Rouncefield, Sommeriville & Viller 2001), Web design (Garzotto, Paolini, Bolchini & Valenti 1999), software engineering (Schmidt, Stal, Rohnert & Buschmann 2000), and Economics (Eriksson & Penker 2000). Recently, design patterns have attracted the attention of the Instructional Design and Education community. Basically, design patterns could be applied to instructional design at two different levels:

1. For learning materials and multimedia production, such as defining patterns for Learning Management Systems. These are actually a subset of Web design patterns (Avgeriou, Papasalouros, Retalis, & Skordalakis 2003)
2. For instructional activities of different scale – from the organization of a whole semester course to specific activities (Bergin 2003)

The design of educational activities could actually benefit from the definition of specific reusable solutions on both levels as they could provide inspiration to designers and enhance and quicken the design process. E<sup>2</sup>ML can support the definition and exploitation of activity patterns, which are called *pedagogical patterns*.

*Pedagogical patterns try to capture expert knowledge of the practice of teaching and learning. The intent is to capture the essence of the practice in a compact form that can be easily communicated to those who need the knowledge. Presenting this information in a coherent and accessible form can mean the difference between every new instructor needing to relearn what is known by senior faculty and easy transference of knowledge of teaching within the community. In essence a pattern solves a problem. This problem should be one that recurs in different contexts. In teaching we have many problems such as motivating students, choosing and sequencing materials, evaluating students, and the like.*

(Pedagogical Pattern Project 2003)

At a higher level, a pedagogical pattern may capture the structure of a course, e.g. how personal work is blended with scaffolding in a Constructivist learning environment, or how face-to-face sessions are alternated to online learning in a mixed mode delivery system. To a lower level, a pattern may represent a discussion, a teamwork development, or an experiment-based session.

### Pattern Relationships

Patterns in all fields are useful if they are related to other patterns of the same kind, and this may happen in two ways:

- Horizontal relationships (Figure 4.6.1) indicate that two patterns on the same level might be related, such as: the implementation of pattern A requires the implementation of pattern B; the implementation of pattern A provides an opportunity for the implementation of pattern B; the implementation of pattern A would benefit from the implementation of pattern B; etc.
- Vertical relationships (Figure 4.6.2) that express an “implements” relationship: pattern B is a possible implementation of pattern A, or pattern X is a possible implementation of a general instructional principle or approach.

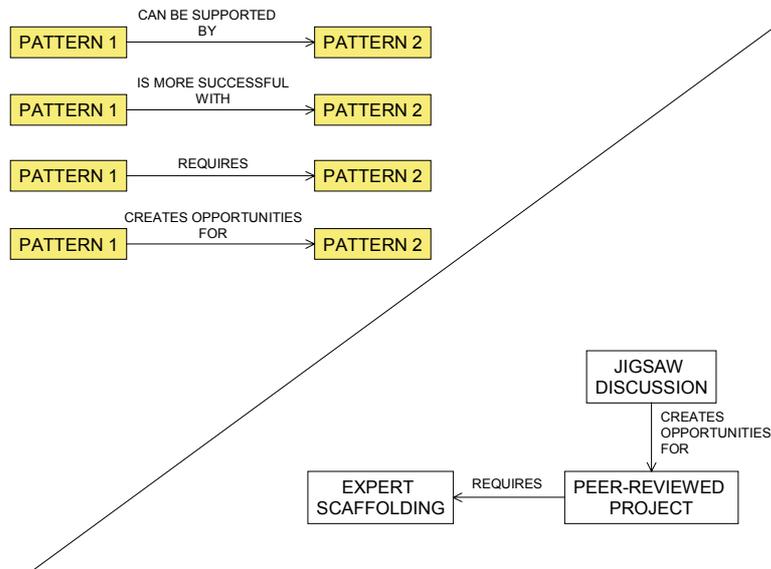


Figure 4.6.1 - Horizontal pattern relationships

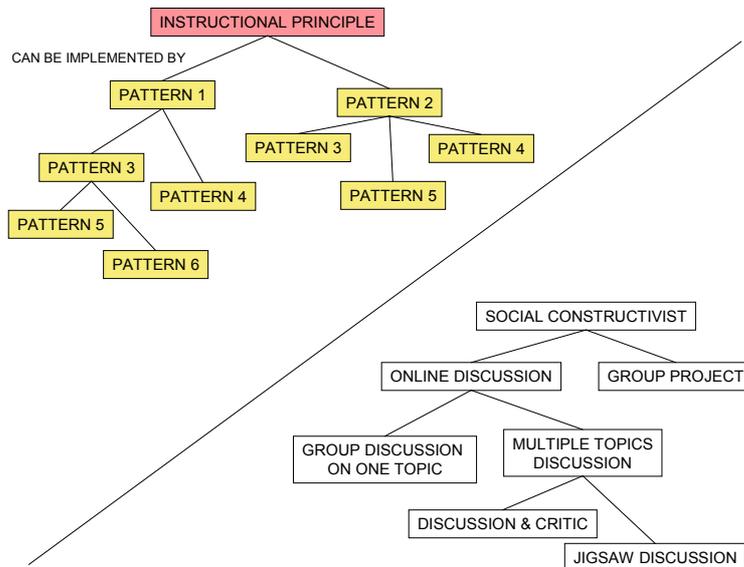


Figure 4.6.2 - Vertical pattern relationships

The discussion of such a pattern system (sometimes also called pattern language – although this may create some confusion with what is presented in the following paragraph) goes beyond the exploratory nature of this short part.

## Pedagogical Pattern Languages and E<sup>2</sup>ML

### *The Necessity of a Pattern Language*

The possibility of defining patterns depends on the existence of a pattern language that allows the synthetic and clear expression of the pattern idea. A pattern is the abstract gist of a solution, and should be the origin of an insight of the instance problem the designer is concerned with – thus opening an original solution fit to *that* specific problem.

Common pattern languages usually define a set of descriptors (i.e. text paragraphs) summarizing the pattern, namely specifying the problem addressed, then describing the solution and eventually providing examples or other additional information. The same structure is used for the definition of pedagogical patterns. An example of pattern by Bergin (2003) in the field of Computer Science is reported in Table 4.6.1.

<b>TITLE</b>	Student Design Sprint (Version 2.1, July 2000)
<b>SUMMARY</b>	Students need to practice design at all levels. This pattern gives them quick feedback and peer review on early attempts.
<b>PROBLEM/ ISSUE</b>	Most educators recognize now that students need to be exposed to design early. Most also recognize the need for team work and for critical analysis. We eventually need to teach system design, but beginners need program design as well. If we don't teach it then students will develop their own ad-hoc techniques that may reinforce bad habits.
<b>AUDIENCE/ CONTEXT</b>	This pattern applies to courses for novices in programming and in design. It can also be used with experienced developers who are new to a topic.
<b>FORCES</b>	Students need to practice design, both program design and system design. But design is hard. They need feedback on early attempts. The quicker the feedback the better. They need to see good designs and to critique poor designs. They need to see the consequences of poor designs.
<b>SOLUTION</b>	This activity can take place in the classroom or in a lab. Divide the students into groups of two (or three). Give them a design problem and ask the teams to produce a design outline in 15 minutes. There should be a written sketch of the design in that time. The instructor can look over shoulders and comment or not, but few hints should be given. Questions should be answered freely. At the end of 15 minutes, the instructor poses a set of questions about the designs without asking for answers. The questions should be such that they cannot be favorably answered by some set of poor designs. The students are then regrouped by combining pairs of nearby groups, so that you now have groups of 4 or five students and each group has two of the original designs. The task is now modified slightly and the groups are asked to produce a new design. After another 15 minutes the instructor again poses a set of questions for thought, regroup the students again into still larger groups, modifies the task slightly and again puts the students to work. This can continue for as many cycles as the instructor wishes. At the end, the instructor should evaluate the resulting designs and make comments. It may be enough to show one or two of the best designs and explain why these are better than the others. If poor designs are also to be shown, it might be best if the names of the designers are not attached. Alternatively, the groups can be required to present and justify their designs and the rest of the class can critique them.
<b>DISCUSSION/ CONSEQUENCES/ IMPLEMENTATION</b>	For some situations one cycle may be all that is needed, followed by a discussion of the issues. In this case the instructor can ask the groups which designs had certain characteristics. This pattern is not restricted to analysis and design. It can be used for program design and data structure design as well.
<b>RELATED PATTERNS</b>	This can lead to a Role Play pattern.

EXAMPLE INSTANCES	<p>Alistair Cockburn has a wonderful exercise for students designing a coffee machine in about three or four cycles in which the requirements become more sophisticated each cycle. In the first cycle the machine can deliver coffee for 35 cents. In the second it can also deliver soup for 25 cents.</p> <p>This can be used in program design in the first and second courses. The task can be to write a function with a given set of pre and post conditions. The tasks in the later cycles can be to tighten the pre conditions and/or strengthen the post conditions.</p> <p>Alternatively, the task could be to develop some code with a given invariant and the questions can involve ways that the invariant might be invalidated by a user if the design is not sound.</p> <p>This pattern can be used in data structure design in the data structure's course. For example, the students can be asked to design a linked list, without telling them how it will be used. They must design a protocol and pick an implementation strategy. The instructor can then suggest some uses to which a linked list might be put and ask if the design supports that use.</p>
REFERENCES	<p>The coffee machine can be found on Alistair Cockburn's web site: <a href="http://members.aol.com/acockburn/">http://members.aol.com/acockburn/</a></p> <p>Role Playing, David Belin, <a href="http://www-lifia.info.unlp.edu.ar/ppp/pp5.htm">http://www-lifia.info.unlp.edu.ar/ppp/pp5.htm</a></p> <p>Incremental Role Play, Jutta Eckstein, <a href="http://www-lifia.info.unlp.edu.ar/ppp/pp7.htm">http://www-lifia.info.unlp.edu.ar/ppp/pp7.htm</a></p>

Table 4.6.1 - A pedagogical design pattern by Bergin

The example reported above provides a straightforward representation of how a pedagogical pattern looks like. The first descriptors (in bold) provide the general description. After that Bergin offers an indication of related patterns, indicating horizontal relationships. Finally, some implementation examples and references are provided. Other pattern languages add the specification of what particular materials are needed for the implementation (e.g. a course Web site or an online forum, etc.).

#### *E<sup>2</sup>ML as a Component of a Pattern Language*

The definition of pedagogical pattern is probably one of the main benefits that E<sup>2</sup>ML may bring to a community of instructional designers – a benefit that is proper of any effective communication tool. E<sup>2</sup>ML can play an interesting role in the definition of pedagogical patterns as its visual orientation may provide an important added value in making the pattern language easier to understand, and patterns more affordable to use, adapt and implement.

Given the scope of this work and the huge number of possible design and organizational applications of patterns, the analysis will be only exploratory, and will happen through the description of three patterns: an E<sup>2</sup>ML translation of the pattern above and the definition of two new patterns, developed in collaboration with DE&T at UBC, Vancouver BC. Other relevant issues, as the definition of a pattern language and of a pattern system, are left in the background as well.

The quality of a pattern is its adequacy to the problem and its straightforwardness – E<sup>2</sup>ML core version will be therefore used, included within the general framework used by Bergin. As we will here focus on single patterns, the *related patterns* descriptor will be omitted. When present, *references* will be reported outside the pattern table.

### **Student Design Sprint**

The *student design sprint* pattern in its E<sup>2</sup>ML version presents two enhancements (Table 4.6.2). First, the *problem issue* descriptor is enriched with a visual representation of the *possible* goals to be addressed with this pattern. White areas and goal type marker indicate that design procedures and principles can be addressed on the *concept*, *reflection*, *commitment*, and *action* levels by implementing this strategy. Learning strategies and interpersonal skills (team work) are instead addressed on the *enquiry* and *insight* levels. Secondly, the activity flow and the dependencies diagram are used for the *solution* descriptor, thus providing a visual aid, at the same time more legible and richer. Notice that the E<sup>2</sup>ML visual syntax fully expresses the formerly textual description, adding to that the dependency view, which may help identifying the prerequisite structure among the sub-activities and the flow of products (solutions, in this case) during the activity.

TITLE	Student Design Sprint (Version E <sup>2</sup> ML, July 2003)
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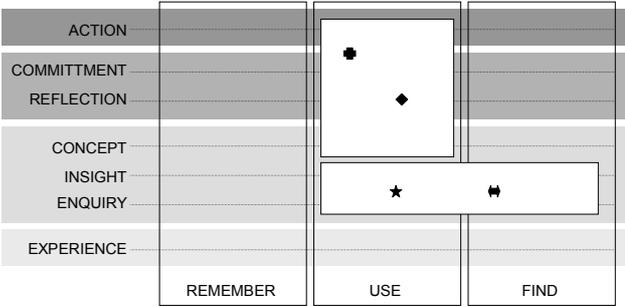
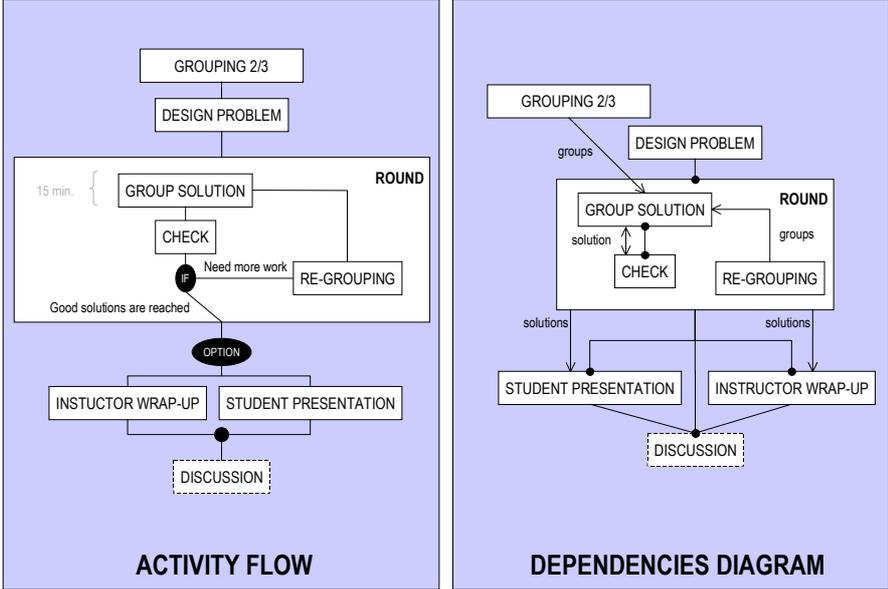
<b>SUMMARY</b>	Students need to practice design at all levels. This pattern gives them quick feedback and peer review on early attempts.
<b>PROBLEM/ ISSUE</b>	<p>Most educators recognize now that students need to be exposed to design early. Most also recognize the need for team work and for critical analysis. We eventually need to teach system design, but beginners need program design as well. If we don't teach it then students will develop their own ad-hoc techniques that may reinforce bad habits.</p>  <p style="text-align: center;"> <span style="display: inline-block; width: 10px; height: 10px; background-color: black; margin-right: 5px;"></span> FACT   <span style="display: inline-block; width: 10px; height: 10px; border: 1px solid black; border-radius: 50%; margin-right: 5px;"></span> CONCEPT   <span style="display: inline-block; width: 10px; height: 10px; border-left: 1px solid black; border-right: 1px solid black; border-bottom: 1px solid black; margin-right: 5px;"></span> PROCEDURE   <span style="display: inline-block; width: 10px; height: 10px; border-left: 1px solid black; border-right: 1px solid black; border-top: 1px solid black; margin-right: 5px;"></span> PRINCIPLE   <span style="display: inline-block; width: 10px; height: 10px; border-left: 1px solid black; border-right: 1px solid black; border-bottom: 1px solid black; margin-right: 5px;"></span> ATTITUDE   <span style="display: inline-block; width: 10px; height: 10px; border-left: 1px solid black; border-right: 1px solid black; border-bottom: 1px solid black; margin-right: 5px;"></span> LEARNING STRATEGY   <span style="display: inline-block; width: 10px; height: 10px; border-left: 1px solid black; border-right: 1px solid black; border-bottom: 1px solid black; margin-right: 5px;"></span> INTERPERSONAL SKILL </p>
<b>AUDIENCE/ CONTEXT</b>	This pattern applies to courses for novices in programming and in design. It can also be used with experienced developers who are new to a topic.
<b>FORCES</b>	<p>Students need to practice design, both program design and system design. But design is hard. They need feedback on early attempts. The quicker the feedback the better. They need to see good designs and to critique poor designs. They need to see the consequences of poor designs.</p>
<b>SOLUTION</b>	
<b>DISCUSSION/ CONSEQUENCES/ IMPLEMENTATION</b>	<p>For some situations one cycle may be all that is needed, followed by a discussion of the issues. In this case the instructor can ask the groups which designs had certain characteristics. This pattern is not restricted to analysis and design. It can be used for program design and data structure design as well.</p>
<b>EXAMPLE INSTANCES</b>	(See above Table 4.6.1)

Table 4.6.2 – E<sup>2</sup>ML version of Bergin’s pedagogical design pattern

Action diagrams could be added, reporting the details for each activity, although we believe that this would not be necessary for such a simple pattern. They will be used in the following examples. From a formal point of view, the activity flow and the dependencies diagram remain unaltered, while a special notation for *possible goals* was introduced in the QUAIL model.

### Online Problem-Based Learning

Problem-based learning is an instructional strategy that aims at involving learners with “real” tasks, so that new knowledge acquisition happens as response to real needs (i.e. generated by the problem), and at the same time transfer is fostered as problems keep the complexity of real-life situations. The point is that different institutions and different designers understand and implement this principle in different ways.

The following pattern (Table 4.6.3) was inductively constructed from the experience done at DE&T at UBC, Vancouver, in a number of online courses in Agronomy. It actually represents a higher-level pattern (a several weeks’ activity) than the one previously reported, which concerned a single session.

<b>TITLE</b>	Online problem-based learning
<b>SUMMARY</b>	Students learn better if knowledge is acquired out of the needs generated by a real problem or task, as their cognitive activity is framed in an engaging situation. The more the proposed problem is real-life-like, the more transfer is enhanced
<b>PROBLEM/ ISSUE</b>	<p>A problem-based approach may address problem-solving principles and procedures, and enhances interpersonal skills (problems are solved collaboratively) and meta-cognitive skills (evaluating the solution process). These goals can be attained on the <i>understanding</i> level, but may also be approached on a critical manner, in order to develop learning on the <i>reflection</i> and <i>commitment</i> levels.</p> <div style="text-align: center;"> </div>
<b>AUDIENCE/ CONTEXT</b>	This pattern applies to learners that can manage their time, operate collaboratively and have some familiarity with the online environment.
<b>FORCES</b>	Students engaged in groups with real problems are more motivated. Groups facing a new problem need guidance. The more the problem is engaging, the more the contribution of guidance is retained. Transfer is enhanced if the learning context matched the professional or real-life performance context.

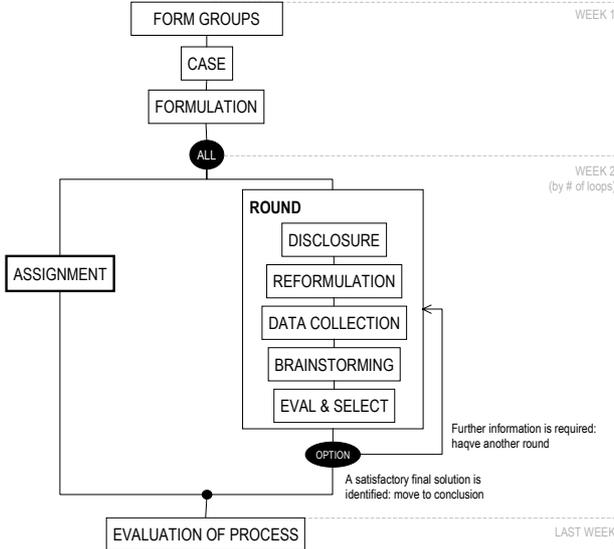
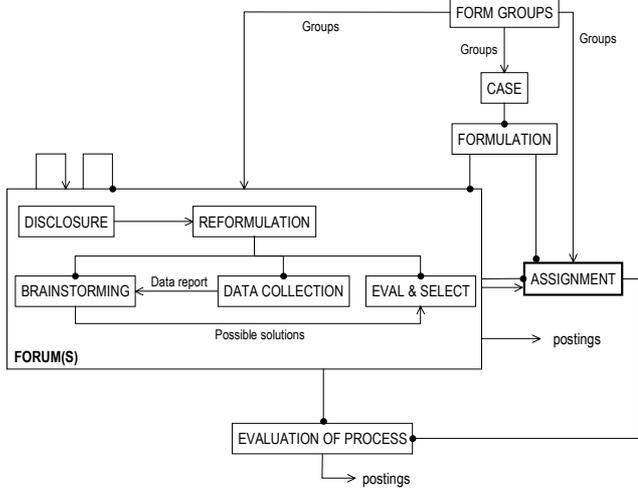
<p><b>SOLUTION</b></p>	<p>The idea is to introduce groups to a case or situation, and to let groups achieve a first understanding (or <i>formulation</i>) of the problem through forum discussion. The work proceeds then in rounds, in which each group defines, refines and selects a solution with the help of the facilitator. Each round introduces new information and documents. Finally, students are asked to evaluate the whole process. While going through this process, each groups composes an assignment, reporting the solution process or formulating the final solution as e.g. a set of guidelines.</p>  <p>The dependency diagram shows how the pivotal point of each round is the reformulation, i.e. the definition of a new understanding of the problem given the solutions previously identified and the new information presented in the disclosure.</p>  <p>More details are provided in the action diagrams presented below.</p>
<p><b>DISCUSSION/ CONSEQUENCES/ IMPLEMENTATION</b></p>	<p>The implementation of this pattern clearly requires a structured set of online materials, which must include a collection of documents with the new information for each round (in the disclosure), and an online discussion forum with private space for each group. Moreover, the facilitator(s) should be keen on understanding the development stage of each group and interact with them properly.</p>
<p><b>EXAMPLE INSTANCES</b></p>	<p>Online courses in Agronomy at UBC.</p>

Table 4.6.3 – E<sup>2</sup>ML version of problem-based learning pattern

The details for actions are reported below, thus providing a complete description of the whole process, with a greater detail than any textual description. The first actions (before the rounds) are defined as follows:

Form groups		FORM GROUPS
Facilitators +(Learners)		SUPPORT
-	-	
-	-	
-	-	
Divide the cohort into groups of 2/3 people each. Assign each group a specific problem.		
GROUPING STRATEGY?		
DUR: 30 min.		
		Anywhere
		Forum

Problem formulation		FORMULATION
Learners (in groups)		LEARNING
[course concepts]		Get an introductory idea of the problem
Read online materials		-
Use the forum		
Notes from case proposition		Notes
WHAT IS THE PROBLEM? WHAT DO WE ALREADY KNOW? WHAT INFO IS MISSING?		
The group discusses online identifying the nature of the problem and getting an understanding of their task		
DUR: 2h		
		Anywhere
Problem statement + guideline questions, Forum		

Case proposition		CASE
Learners (single)		LEARNING
[course concepts]		Get an introductory idea of the problem
Read online materials		-
-		Notes
Each member of the group reads the problem statement (+eventual data or other information), takes notes and figures out what the group task is.		
DUR: 2h (depending on the length of readings)		
		Anywhere
Problem statement		

Figure 4.6.3 - PBL pattern actions (1)

The round actions are represented in Figure 4.6.4 to Figure 4.6.6.

Disclosure		DISCLOSURE
Learners (in groups) + facilitators		LEARNING
General idea of the problem		Problem analysis skills
Status of the solution		
Group discussion skills		-
Use of the online forum		
Materials from the previous round		• Task statement • Plan for actions
Students read online materials providing:		
• New information		
• Guideline questions for the next step in problem solving		
DUR: 2h		
		Anywhere
Forum (group support)		

Problem reformulation		REFORMULATION
Learners (in groups) +facilitators		LEARNING
General idea of the problem		Problem analysis skills
Group discussion skills		-
Use of the online forum		
Notes from DISCLOSURE		• Structured problem definition • Identification of missing info • Task statement • Plan for actions
Each group discusses to get a clear understanding of the problem at the current step. Focus on required info and task.		
DUR: 2h		
		Anywhere
Forum (group support)		

Figure 4.6.4 - PBL pattern actions (2)

Data collection		DATA COLLECTION
Learners (in groups) + facilitators		LEARNING
Identification of missing information; task statement	<ul style="list-style-type: none"> <li>Information retrieval abilities</li> <li>Relevance strategies</li> <li>Information search strategies</li> </ul>	
Information retrieval Use of the online forum	-	
Plan for action from FORMULATION	Required information	
Each group looks for the information missing, and collects it in a structured manner.		
DUR: 4h		
Anywhere		
Forum (group support)		

Brainstorming		BRAINSTORMING
Learners (in groups) + facilitators		LEARNING
General idea of the problem	<ul style="list-style-type: none"> <li>Brainstorming techniques</li> <li>Creative thinking</li> </ul>	
Task statement	-	
Group discussion skills Brainstorming techniques Use of the online forum	-	
Plan for action +new info from DATA COLLECTION	List of possible solutions	
The group identifies possible solutions to the problem; describes them according to indicators		
DUR: 4h		
Anywhere		
Forum (group support)		

Figure 4.6.5 - PBL pattern actions (3)

Solution Evaluation & Selection		EVAL & SELECT
Learners (in groups) + facilitators		LEARNING
General idea of the problem	<ul style="list-style-type: none"> <li>Solution analysis</li> <li>Evaluation and selection strategies</li> </ul>	
Task statement	-	
Group discussion skills Use of the online forum	-	
List of solutions from BRAINSTORMING	Final solution	
The group discusses the solutions, evaluates them and selects the solution to be "officially" proposed		
DUR: 2h		
Anywhere		
Forum (group support)		

Figure 4.6.6 - PBL pattern actions (4)

Finally, the concluding actions (assignment writing and evaluation) are reported in Figure 4.6.7.

Assignment Writing		ASSIGNMENT
Learners (in groups)		LEARNING
Experience done in the problem solving	Critical evaluation of the problem solving strategy	
Group discussion skills Use of the online forum Writing skills	-	
Documents from FORUM	Report	
The group organizes the writing of a document reporting the problem solution and accounting the solution strategy and the group work		
DUR: 6h		
Anywhere		
Forum (group support), report guidelines, problem statement		

Evaluation of the process		EVALUATION
Learners (single)		LEARNING
Experience done in the problem solving	Critical evaluation of the problem solving strategy	
Use of the online forum	-	
-	Evaluations (in forum postings)	
The learner evaluates, according to the objectives stated for the activities: <ul style="list-style-type: none"> <li>him-/herself</li> <li>his/her colleagues</li> <li>the group</li> <li>the facilitator</li> </ul> Evaluations are to be put in the group forum.		
DUR: 1h		
Anywhere		
Forum (group support), evaluation guidelines, activity goal statement		

Figure 4.6.7 - PBL pattern actions (5)

This pattern was implemented in a number of UBC courses. A screenshot of the online materials for round 3 in case 1 of AGRO 260 is reported in Figure 4.6.8. The learning environment was developed with WebCT, and included chat and discussion forum support for the groups (see the menu in the left side bar). Notice the additional materials proposed to the groups along with the discussion questions (guidelines for the round).

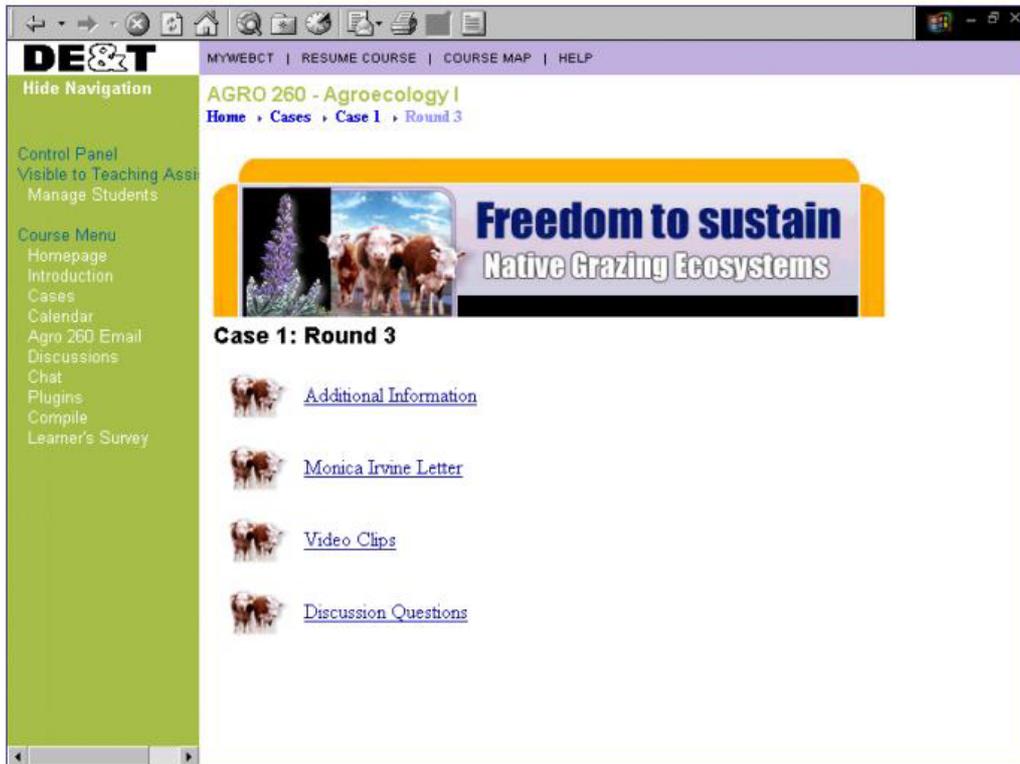


Figure 4.6.8 - PBL pattern implementation screenshot

The pattern activity flow was also used for explaining the students how the problem-solving activity was structured. A more appealing diagram was developed, as reported in Figure 4.6.9.

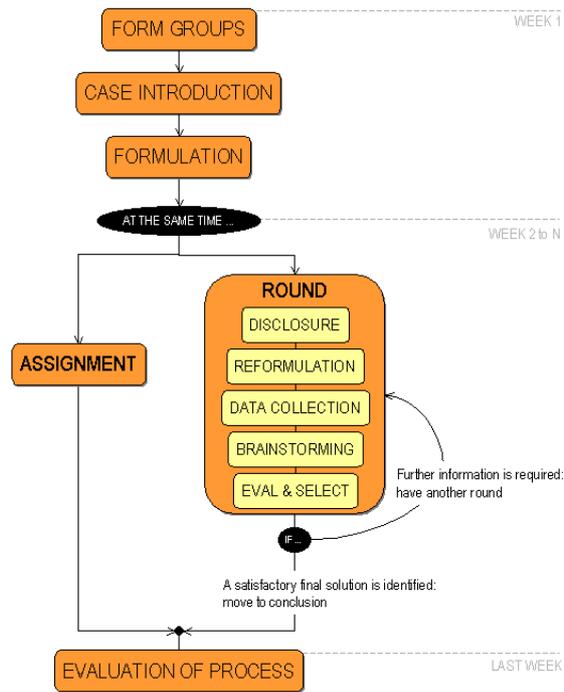


Figure 4.6.9 - Student representation of the PBL activity flow

The online problem-based pattern is a tool for designing online courses with a problem-based approach, and it offers one possible implementation of such instructional principles. From this point of view, the availability of a standard and semi-formal pattern language may improve critical discussion between researchers and practitioners.

### Online Read & Discuss

This pattern is a simple structure that may be used for online courses where individual work on specific documents and critical discussion are central. This method properly applies to almost all Humanities, such as Literature, Law or History, where documents (as different from data or theorems) represent the primary object of study. The tenet or principle underlying this pattern is that group discussion enhances the understanding of documents and the construction of meaning.

<b>TITLE</b>	Online Read & Discuss
<b>SUMMARY</b>	Students need time to approach personally important documents, read, analyze and understand them. Critical discussion with peers and with the instructor may refine their understanding and motivate them.

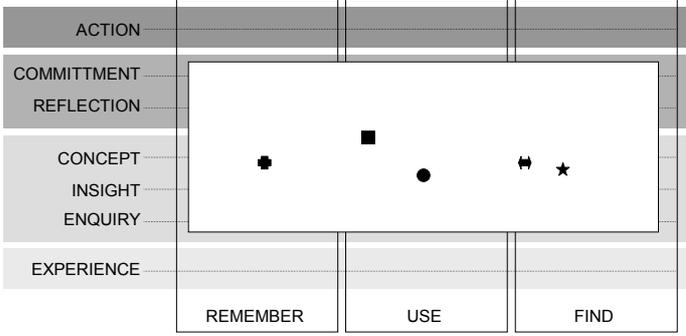
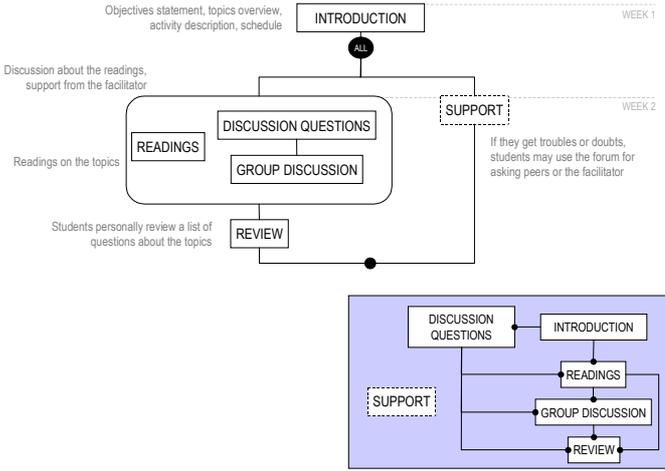
<b>PROBLEM/ ISSUE</b>	<p>Depending on the type and content of documents, this pattern may address different types of goal. Generally speaking though, it addresses the <i>understanding</i> and <i>judgment</i> levels concerning the documents. Special attention should be paid to the development of interpersonal skills through discussion, and to the acquisition of meta-cognitive skills by comparing one's understanding with the group.</p>  <p style="text-align: center;"> <span style="display: inline-block; width: 10px; height: 10px; background-color: black; margin-right: 5px;"></span> FACT   <span style="display: inline-block; width: 10px; height: 10px; border-radius: 50%; background-color: black; margin-right: 5px;"></span> CONCEPT   <span style="display: inline-block; width: 10px; height: 10px; border-left: 1px solid black; border-right: 1px solid black; margin-right: 5px;"></span> PROCEDURE   <span style="display: inline-block; width: 10px; height: 10px; border-left: 1px solid black; border-right: 1px solid black; border-bottom: 1px solid black; margin-right: 5px;"></span> PRINCIPLE   <span style="display: inline-block; width: 10px; height: 10px; border-left: 1px solid black; border-right: 1px solid black; border-top: 1px solid black; margin-right: 5px;"></span> ATTITUDE   <span style="display: inline-block; width: 10px; height: 10px; border-left: 1px solid black; border-right: 1px solid black; border-bottom: 1px solid black; border-top: 1px solid black; margin-right: 5px;"></span> LEARNING STRATEGY   <span style="display: inline-block; width: 10px; height: 10px; border-left: 1px solid black; border-right: 1px solid black; border-bottom: 1px solid black; border-top: 1px solid black; margin-right: 5px;"></span> INTERPERSONAL SKILL </p>
<b>AUDIENCE/ CONTEXT</b>	<p>This pattern applies to any subject area where personal approach to relevant documents is of primary importance. Learners should be skilled in reading the kind of proposed documents, and should not have language or comprehension problems. Moreover, they should have basic online communication skills.</p>
<b>FORCES</b>	<p>Students can take the time for personally approaching relevant documents, still maintaining deadlines and group discussion. Critical understanding of documents is enhanced by discussion.</p>
<b>SOLUTION</b>	<p>The activity starts with the reading of introductory materials (presenting the topic and the activity structure), and then proceeds with the reading of the documents. Online group discussion proceeds at the same time, engaging students in collaboratively understanding the documents. After the discussion is over, some revision questions are proposed. Students that experience difficulties in answering them may request support in the forum.</p> <p>The dependencies diagram, reported bottom-right, indicates the flow-like activity of this pattern. Although simple, details are provided in the action diagrams below.</p> 
<b>DISCUSSION/ CONSEQUENCES/ IMPLEMENTATION</b>	<p>The implementation of this pattern requires a structured forum with group support. Notice that students may be given particular roles in the discussion.</p>
<b>EXAMPLE INSTANCES</b>	<p>History course at UBC; SWISSLING modules in Lugano.</p>

Table 4 – E<sup>2</sup>ML version of the read and discuss learning pattern

Action diagrams (Figure 4.6.10 and Figure 4.6.11) propose some more detail of the pattern.

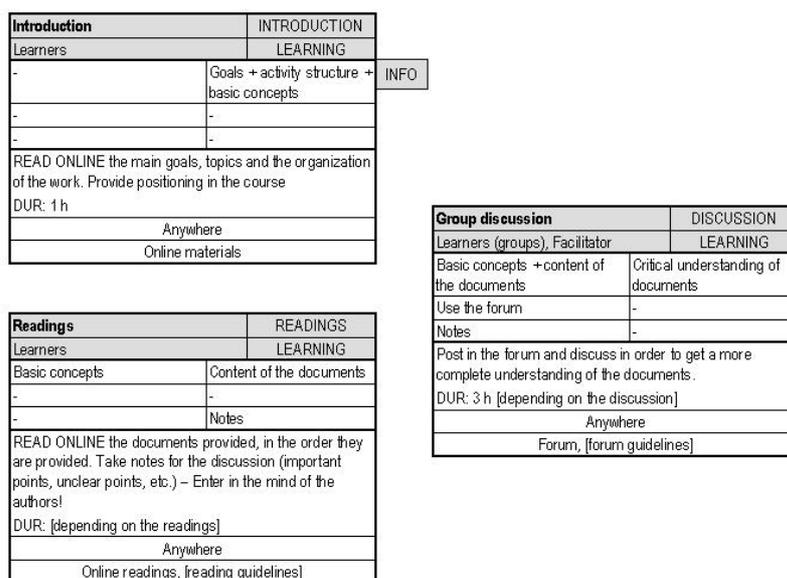


Figure 4.6.10 - Read & Discuss pattern actions (1)

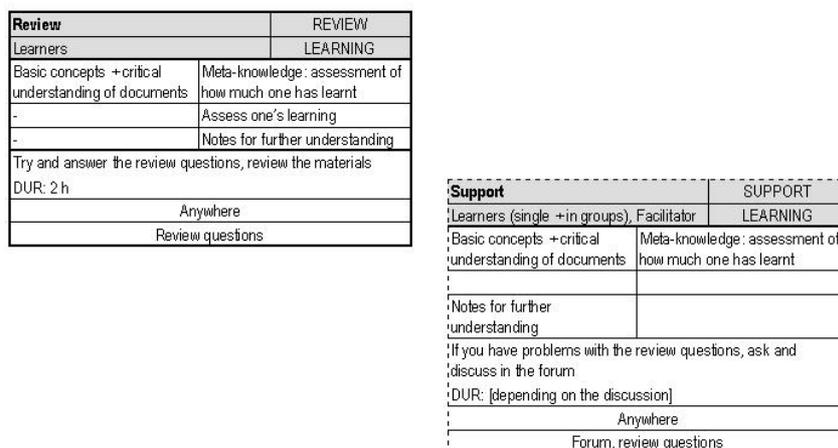


Figure 4.6.11 - Read & Discuss pattern actions (2)

This pattern was extensively used in a History course at UBC about *Slavery in the Americas*. The basic course module was indeed modeled on the read & discuss pattern – documents were primary sources that students had to read after the introduction provided by the instructor’s notes. Personal assignments were to be submitted, concerning the work done in the modules, and a final exam concluded the evaluation. The whole course was accompanied by the instructor’s scaffolding activity, available through the discussion forum, and was more intense in the beginning of the course, declining in proportion to the students’ acquired autonomy.

The general course structure was as follows (M indicates the modules and A the assignments):

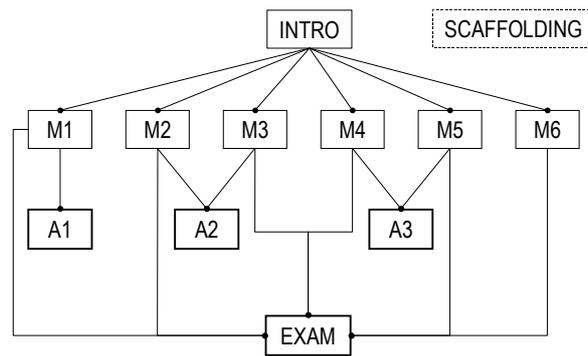


Figure 4.6.12 - Slavery in the Americas: dependencies diagram

Each M action (module) was then structured according to the pattern, with readings, discussion and revision. Notice that although for A2 and A3 students could chose between two different topics, presented in different modules (M2 and M3 for A2; M4 and M5 for A3), the problems to be discussed in the assignments required both topics.

The activity flow (Figure 4.6.13) is perfectly linear: it assigns two weeks to each module, and one assignment every fourth week. Notice the continuous scaffolding activity accompanying the course.

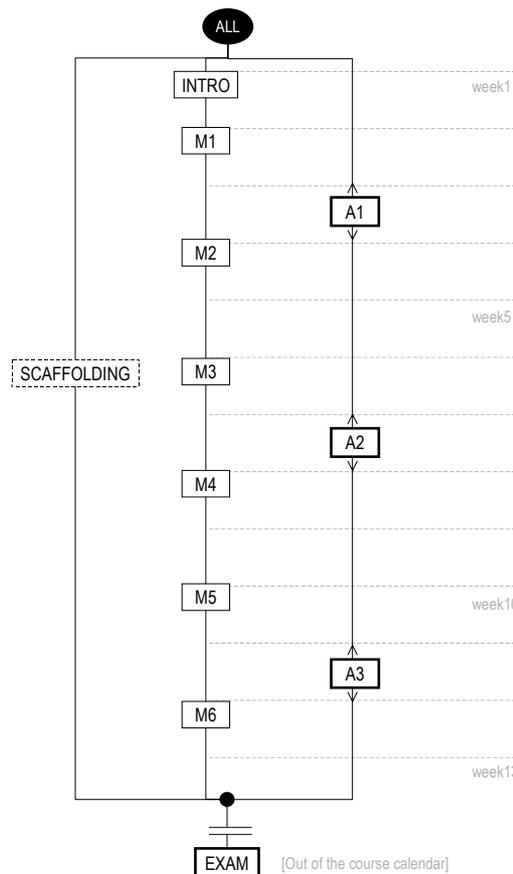


Figure 4.6.13 - Slavery in the Americas: activity flow

## Remarks

### *Implementing a Pattern*

The availability of a straightforward definition of a pattern is an important prerequisite for its effective exploitation. A pattern in fact does not only represent a possible design solution, but also the principle for its practical implementation.

Imagine an organization that consistently uses patterns in its courses: once a designer selects a specific pattern, such as the online problem-based learning, the implementation of the course could then rely on a ready-made template, including the structure of the online materials (this would enhance communication with Web programmers), the logistics of the implementation, the interaction with the instructor, the staff roles in running the course, etc.

Patterns can be used not only in design, but as well for teaching instructional design to prospective designers. Under this respect, a partially visual representation of patterns acquires a great importance. Moreover, if expressed with a common language, patterns developed by different design communities may provide a way to compare different understandings and implementations of the same instructional principles and theories. The use of visuals may improve the process.

### *Problems and Goals*

Pattern experts may notice that the QUAIL model was introduced in the *problem/issue* descriptor. This may seem inappropriate, as the goal mapping is not the description of a problem. Nevertheless, we believe that patterns become useful only when an accurate requirements analysis is conducted – designers have the problem of selecting patterns only when they know what goals their design aims at. Moreover, the definition of pattern problems in a formal way, such as with the QUAIL model, may offer a chance to compare patterns, systematically classify them, and finally search and retrieve them by querying a specific goal definition.

## Summary

The five case studies presented in this Chapter showed extensively E<sup>2</sup>ML in practice, and proofed its flexibility and expressive power on courses on different topics, exploiting different delivery modes, with different institutional, pedagogical and technological constraints and needs. Moreover, each case study presented a different design process and a different design team at work. Finally, the degree of detail of the modeling was different according to the needs of each instance. Both the Core and Advanced versions were used, according to the situation. Specific points of interest were highlighted, concerning the use of E<sup>2</sup>ML, on-purpose extensions, and specific expressive devices.

The short exploration of the domain of pedagogical patterns also showed a possible use of E<sup>2</sup>ML for representing possible solutions to recurrent design problems in a simple, intuitive and readable way.

Chapter V, right before the conclusion, will provide some elements for a preliminary evaluation of E<sup>2</sup>ML and of its deployment in the instructional design process.



## CHAPTER V

# PRELIMINARY EVALUATION

*“Learning is haphazard; instruction is planned.”*

*(Kemp, Morrison, & Ross 2003, p.2)*

After that E<sup>2</sup>ML has been developed, refined and tested on a set of real cases, the next step is the evaluation of its impact on the practice of instructional design. For several reasons – some of which are presented below - such an evaluation would require a large effort, and is beyond the scope and the dimension of this work. Nevertheless, given its importance, every effort was made in order to provide hints for it, in two senses:

1. Collecting indications of what could and should be evaluated of E<sup>2</sup>ML.
2. Reporting the results of focus groups and interviews with experienced instructional designers about E<sup>2</sup>ML.

## What Could Be Evaluated?

### Issues in Evaluation

Evaluating a language is not an easy task, although E<sup>2</sup>ML is a disciplinary and semi-formal language. The use of languages is the result of complex interactions among the speakers and among the community of speakers and other communities, and their effectiveness is tightly connected to creativity. In some sense, a language is a flexible and continuously developing tool. Moreover, the specific domain of instructional design is incredibly complex and manifold.

Some indications about the evaluation of E<sup>2</sup>ML, or of a similar language, have been formulated as issues in the following paragraphs.

#### *Context Sensitivity*

E<sup>2</sup>ML is primarily a visual language and a tool, and as such, its actual use and effectiveness strictly depend on the designer, the type of instruction to be designed, and the overall institutional and educational context. The complex connection between these elements makes it difficult to define an evaluation protocol. It has been observed that E<sup>2</sup>ML is suitable for system-level design; nevertheless, while some courses would benefit from it (for example a mixed-mode course), other courses even in the same institution may not (for example a face-to-face lecture series). At the same time, some designer may feel so comfortable with it to use it also for quick design of small courses, where it would otherwise not be useful. Another side of the issue is the interaction with instructors or course authors, which may be more or less willing or able (they might be even scared!) to rely on semi-formal diagrams for their work with the designer.

#### *Eclectic Benefits*

Trying to evaluate a tool, one should figure out what benefits it brings to its users. The goals for which E<sup>2</sup>ML was developed provided some indications, but it is worthwhile to recall that not all of them could be reached in all situations, and that designers may use it also for achieving a particular goal. For example, some may use it as it makes easy to revise courses, although it requires some additional time for the first design; some others may use it a standard visualization for all courses, so that any designer can quickly get the rationale of any course; etc. Any research claiming that E<sup>2</sup>ML (or a similar language) let designers “save 15% of design time” or “put up your course in 10 days” would not be serious.

#### *Course Quality Assessment*

The uniqueness of each educational environment, as a whole composed by a subject matter, a method of instruction, a class, the teaching staff and the tools, makes the quality assessment of a single course problematic, as the large number of pages about evaluation in the literature testifies. Is a course a good course because all learners achieve the objectives, although none of them was able to do any other

course in the same semester because of work overload? Is a course a good course because the 3D animations developed for it won a prize, although the course overspent budget? The elements to be considered are many, and often tightly intertwined.

The comparison of two courses exponentially increases the difficulty, as no parameters can be set for both of them in order to identify variables: for example, no two courses on the same topic may have the same class with the same entry level; and no two similar courses can be designed by the same designer with the same level of expertise. It would be therefore hazardous (if not unethical) to try and develop two similar courses with and without E<sup>2</sup>ML in order to see which one gets the best outcomes. Even if one could succeed in developing two perfectly comparable courses, the implementation of teaching and learning takes place in the unrestricted realm of chance. No lecture or activity simply depends on how it was designed, or on the materials developed to support it – the digestion of the previous day's dinner influences people the next morning, and a technical breakdown may spoil a great session in a definitive way.

### *The Importance of Time*

Time is of paramount importance in the development and integration of a language within a community. Designers would require enough time for learning E<sup>2</sup>ML, and then for adapting it to their specific situation. The progressive rearrangement and smoothening of the language is an important and deciding process, as it should be considered that the language for a community should be developed by the community, and be thoroughly negotiated.

It is indeed likely that the introduction of E<sup>2</sup>ML would lower productivity for a little while, raising it afterward to a level higher than the initial one – as usual with the introduction of a new tool in a workspace.

A complete evaluation program should therefore observe the evolution of the design practice with E<sup>2</sup>ML and of the quality of the instruction over a long period, maybe one year, and over more courses.

### *The Impossible Experimental Condition*

All these issues are made more difficult in the perspective of implementing an evaluation plan. It is clear that the choice of introducing E<sup>2</sup>ML should be taken at a community, if not institutional, level, as it has a definite impact on the work practice, and should be considered as a possible investment. Moreover, under the respect of their professional activity, people are complex systems: E<sup>2</sup>ML, if used, is not an element that can be injected and then removed. If designers learn to use it, it will remain at least as part of their background. Finally, E<sup>2</sup>ML could be tested only on real courses – this means in interaction with course authors, instructors, Web developers, etc., and with all the pressures that deadlines and budget bring.

For these very reasons, it is impossible to create an experimental condition where variables can be controlled: was the design successful because of E<sup>2</sup>ML or because the deadline was far enough to allow the right time for development?

Even if a controlled experiment could be performed, it would raise ethical issues. Is it fair, if you have 100 students, let 50 of them follow an E<sup>2</sup>ML developed course and the rest a different one? And is it fair to put the risk of introducing a new design language while developing a course for one instructor only?

These are only a part of the issues that must be considered in the evaluation of a design language, and others could be listed: no two design teams work the same way; the choice of technologies has an impact on design; the different personal and cultural degrees of openness and will to collaborate of designers and instructors, etc. All this caused the present work to restrict its scope to the development of E<sup>2</sup>ML, and to a preliminary survey of its acceptance.

## Elements for Evaluation

Given the issues that a complete evaluation program should consider, what elements of E<sup>2</sup>ML could be evaluated? The following paragraphs try to put forth some hints.

### *Specific Sub-activities*

The quality of a tool is its adequacy to a problem solving activity for its users. Given the complexity of instructional design, specific and limited sub-activities could be observed, and this may provide elements for evaluation. An example would be a new designer in charge of redesigning two courses developed by someone else: she has only the course materials for the former, and a complete E<sup>2</sup>ML documentation for the latter. Her evaluation of her work, and of the aid of the documentation, along with a measure of effectiveness (e.g. time spent), would offer a measure of the impact of E<sup>2</sup>ML on a particular situation. Like this, several other small scenarios could be identified such as the redesign of a unit, or the adaptation of a course to a different target, etc.

### *Communication Events*

In the same way, specific communication events could be observed as part of the sub-activities of the design process. For example, the meetings of a design team could be videotaped in order to see the role that E<sup>2</sup>ML diagrams play when discussing objectives or activities. The effectiveness of meetings could be partially assessed measuring their duration and recording the judgment of the designers who took part in it. The use of diagrams for involving stakeholders could also be another interesting point.

### *Institutional Changes*

The assessment of the institutional and organizational changes that E<sup>2</sup>ML would bring in a community of designers would provide additional interesting elements. The impact of a language in fact, should be also observed on the social dimension. The possibility to create a shared repository of courses, or to define pedagogical patterns, is likely to change the interactions among designers.

An evaluation would include the training and integration process of novice designers, the sharing of expertise and best practices, the reuse of design, and the communication inside and outside the team – as elements of knowledge management.

Also at stake would be the guidance of the transformation: who is sponsoring the exploitation of E<sup>2</sup>ML? What are the major drivers? What the perceived benefits and fears? Diffusion Theory (cf. Rogers & Shoemaker 1971) would provide a solid background for this part of the evaluation.

### *Expressive Power*

One of the most important intrinsic features that make a language useful is its expressive power, i.e. the extension of the domain of objects that it can describe. Can E<sup>2</sup>ML equally well represent instruction delivered with different media, or in different settings? Can it grasp the essence of different pedagogical approaches? The case studies suggested that it is expressive enough, but an extensive application of E<sup>2</sup>ML to different cases would undoubtedly bring an interesting contribution, along with precious indications for a further refinement of the language.

### *Actual Users*

Finally, a tool is a good tool if the people who are supposed to use it actually use it. Stradivari violins are not good because music critics write so, but because good performers choose them. Although probably no communication expert wrote a paper about SMS messages for cellular phones before 2001, people use them because they like them and they suit to real communicative situations. In some years, a good question would then be: “Who is using E<sup>2</sup>ML? How? Why did they choose it?”

## Feedback from Expert Designers

### Setting

Feedback was collected between May and August 2003 from experienced designers, at the time all employed as course designers or course developers in Higher Education institutions in Canada and the United States<sup>1</sup>. The feedback collection took two main forms:

1. Two focus groups with 3 and 6 designers respectively were held at DE&T, University of British Columbia – Vancouver. Despite all belonging to the same institution, the designers actually have different backgrounds (computer science, media production, instructional design, education, and religious studies) and different ways of doing design. E<sup>2</sup>ML Core Version was presented along with the analysis of the *Istituzioni 3* case study and the presentation of the problem-based learning pedagogical pattern.
2. 12 designers were interviewed and then required to fill in a feedback form after they had assisted to a group or individual presentation of E<sup>2</sup>ML Core Version, or after reading a paper presenting the language and some case studies. Designers came from the University of British Columbia, Simon Fraser University and Stanford University.

Notice that all the designers who provided feedback were just introduced to E<sup>2</sup>ML Core Version – their feedback consequently expresses the first reaction to the new tool, and might be considered a measure of their potential willingness to adopt it, or their perception of its usefulness for their practice. All sentences in double quotes in the following paragraphs report the designers' wording.

Although with a small sample population, and no claim of soundness or completeness, such feedback collection provides useful elements in order to:

- Set up a more structured, extensive and exhaustive evaluation of E<sup>2</sup>ML.
- Refine the model.
- Identify relevant issues in the deployment of E<sup>2</sup>ML in the design process.

### Focus Groups

The first remark pointed out by the designers is that E<sup>2</sup>ML is a novel kind of tool in the field of Instructional Design, thus confirming the conclusion drawn from the literature review in Chapter I. QUAIL, on the other hand, can be located within a wide set of tools for the definition and classification of learning goals, as discussed also in Chapter I.

The overall impression that all designers expressed during the focus groups is that E<sup>2</sup>ML looks potentially powerful, extremely flexible and adaptable to different strategies and situations. Its main innovative feature is its visual orientation, which provides a synthetic view of the instruction: they confirmed that they develop a mental image of the course that they never express, if not implicitly in the course materials, and that can be visualized with E<sup>2</sup>ML, providing “an interesting focus for the discussion” in the design team.

According to their perception, E<sup>2</sup>ML is mostly useful for keeping the overall consistency of a course, and in particular:

1. To discuss the consistency of goals and instructional activities (as general approach, activity structure and assessment) with the instructors or course authors: “they usually discuss the goals and then forget them in the actual planning”. “A consistent strategy is something difficult to explain, and visualization is an important support”.

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<sup>1</sup> The sample does not contain any designer from Europe, as it is rare and unusual that someone is employed with such a role in Higher Education institutions.

2. To blueprint a course, as it “works well in organizing people's thinking”, and “may speed up collaboration”. Moreover, action diagrams actually provide a higher degree of detail than the usual blueprinting.
3. To “make the evaluation more evident”, identifying activities in which the achievement of specific goals is assessed.

The main problems with E<sup>2</sup>ML may be summarized in two points:

1. While designers feel E<sup>2</sup>ML could be learnt in a reasonable amount of time, its complexity may make it difficult for instructors and course authors – “it has, from what I can see, a steep learning curve”. From this point of view, visual learners might be favored, although designers do not think this is a prerequisite for using E<sup>2</sup>ML.
2. The QUAIL model represents probably the greatest obstacle, as it requires familiarity with a number of concepts, and the chance to use different taxonomies (as Bloom’s) or visual aids (as Anderson & Krathwohl’s grid) is important. The general idea the designers expressed is that “any model for goals is fine, as long as the (course) author can understand it.”

Besides the design activity, E<sup>2</sup>ML is felt as a possible support for communicating the structure of activities to the students.

From a practical point of view, all designers agree that E<sup>2</sup>ML should come with templates or a specific software application.

Finally, two more formal considerations emerged:

1. The flexibility of E<sup>2</sup>ML with regard to learning objects on the one hand, and the necessity of a specific product-oriented model for the development of specific resources.
2. Time and durations are not evident in E<sup>2</sup>ML.

### Feedback Interviews

The specific data collected through interviews and feedback forms provided comparable feedback from 12 designers. Each interview was a semi-structured discussion of the model on the basis either of the oral presentation of a case study or a reading of a paper also presenting case studies. After that, interviewees were asked to formalize their answers in a feedback form. The feedback form was organized in four main parts (the whole form is reported in Appendix C):

1. Scenarios: designers were presented short descriptions of situations, and then asked if E<sup>2</sup>ML would have been a support for the specific instance.
2. Statements: designers were presented some general statements about E<sup>2</sup>ML, and they were asked to check the ones they felt true. Half of the statements indicated positive features, half negative ones.
3. Free comments.
4. Contacts of people who might be interested in E<sup>2</sup>ML.

The results of the interviews confirmed the results of the focus groups, providing elements for their correct interpretation.

#### *Scenarios*

Table 5.1 reports the scenarios descriptions, along with a synthetic statement of the E<sup>2</sup>ML feature at stake

SCENARIO	KEY
You are in the development team for a course in Economics along with a faculty, a subject expert from the corporate world and a Web programmer. It looks like you talk different language and it is not easy to understand each other. Would E <sup>2</sup> ML enhance internal team communication?	Team communication enhancement

You are tight on schedule with a course, and you run to the Web programmer for having things online in the next few days. Unfortunately, the Web developer is on holiday – you find a newly hired guy to replace him. Would E <sup>2</sup> ML support Web material development, and support the new guy in understanding what you want him to do?	Material development
The authors of a course have decided to use a mixed face-to-face and online strategy, which is also new for you under some respect. Would E <sup>2</sup> ML support checking if the course would work as one consistent whole before trying it with real student (quality assessment at design time)?	Consistency
A course requires the intervention of tutors in a number of different activities. It looks like they will be working very hard. Would E <sup>2</sup> ML help detecting work overload time spans tutors?	Overload time spans
A course did not work – a lot of students drop out. Would E <sup>2</sup> ML serve as a diagnostic tool and identify what to redesign?	Diagnostic tool
Last year you developed a successful course, and the President want it replicated this year. The problem is that the materials should be updated, and the original author has retired. Would the E <sup>2</sup> ML documentation help working with the new author for reusing/readapting the instruction?	Adaptation (different instructor)
In the same situation as above, what if the same course, with the same author, is offered to a different target (e.g. students from a different Faculty)?	Adaptation (different target)
You meet a colleague from Louisiana, and you discuss with him the way you do courses. You say you try to be constructivist, and the same says he. But going on you actually disagree on a number of practical decisions in course development. Would E <sup>2</sup> ML be useful for more effectively comparing designs and courses?	Compare courses
Would the E <sup>2</sup> ML documentation be useful for checking the implementation status of a course?	Checking implementation status
A new young course developer is hired at DE&T. You are asked to mentor him and teach him some tricks. Would E <sup>2</sup> ML representation of courses be useful to let her see the way you do your job and the types of decisions you take?	Teaching novice designers

Table 5.1 - scenarios

The feedback results are summarized in the following chart: each feature is represented as a bar, as indicated in the chart key. Values go from 0 (the feature is not supported by E<sup>2</sup>ML) to 2 (the feature is well supported by E<sup>2</sup>ML). Intermediate values should be intended as degrees of possibility: 1 means something like “It is possible to use E<sup>2</sup>ML in order to do that, but it would require some rearrangement”.

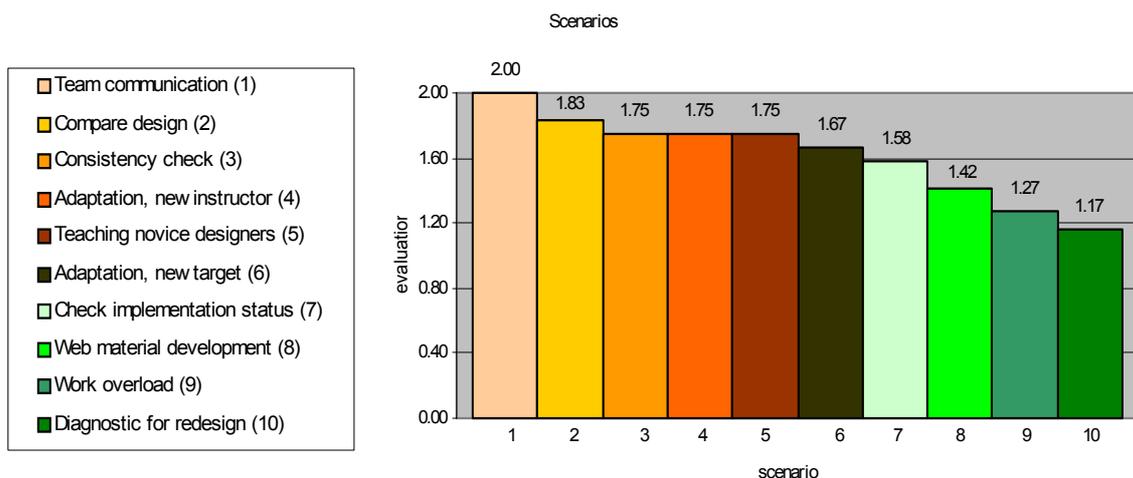


Figure 5.1 - Scenarios evaluation chart

All interviewed designers basically felt that all the proposed features corresponded to the actual definition of E<sup>2</sup>ML. In particular, all of them expressed confidence that E<sup>2</sup>ML can enhance team communication (bar 1) and support the comparison of different designs (bar 2). Also very high confidence was expressed for the use of E<sup>2</sup>ML as a language for keeping the overall consistency of the instruction (bar 3), adapting a course when the instructor changes (bar 4) and for teaching novice designers (bar 5).

The use of E<sup>2</sup>ML for the adaptation of existing designs with different students (bar 6) has a slightly lower score. Designers feel that E<sup>2</sup>ML may be useful for working with the instructor, while changing student target often means redesigning the course from scratch. Comments about these scenarios pointed out that the rationale of a course is given by the epistemological beliefs of the instructor – Richards & Rodgers (1982) *approach* layer – and that often effective learning depends more on that than on the design of specific activities or on the quality of support materials – the *design* layer –, where E<sup>2</sup>ML seems to be more applicable. As was already discussed in Chapter II, E<sup>2</sup>ML does not grasp the overall epistemological and scientific approach of a course; at the same time, the approach is the source of the activities that E<sup>2</sup>ML simply represents.

The use of E<sup>2</sup>ML for checking the implementation status (bar 7) also got a middle confidence score, while lower confidence was expressed regarding the use of E<sup>2</sup>ML for the development of instructional materials (bar 8): designers feel that it is too high-level for implementation, and that what they usually pass to Web programmers is a more specific description, or some content to be put on the Web.

Noticeably, the lowest confidence is for two important elements: the identification of workload (bar 9) and the use of E<sup>2</sup>ML as a diagnostic tool (bar 10). Although both of them got a final score above 1, the result shows a large space for improvement.

### Statements

The statements proposed to the designers indicated positive and negative features. One last statement concerned the development of an E<sup>2</sup>ML application. They are the following:

- Positive statements:
  - E<sup>2</sup>ML can enhance the quality of instruction.
  - E<sup>2</sup>ML can support the implementation of more challenging design solutions for education.
  - E<sup>2</sup>ML can smoothen the design process.
- Negative features:
  - E<sup>2</sup>ML is too complicated.
  - E<sup>2</sup>ML has too many elements.
  - The effort E<sup>2</sup>ML required in writing the documentation is not rewarded anyway.
- E<sup>2</sup>ML would be nice if it could be used with a software application.

Unlike for scenarios, designers had here a binary choice: the statement applies or not. The results are reported in the following chart, where the values (between 0 and 1) represent the average score for each statement.

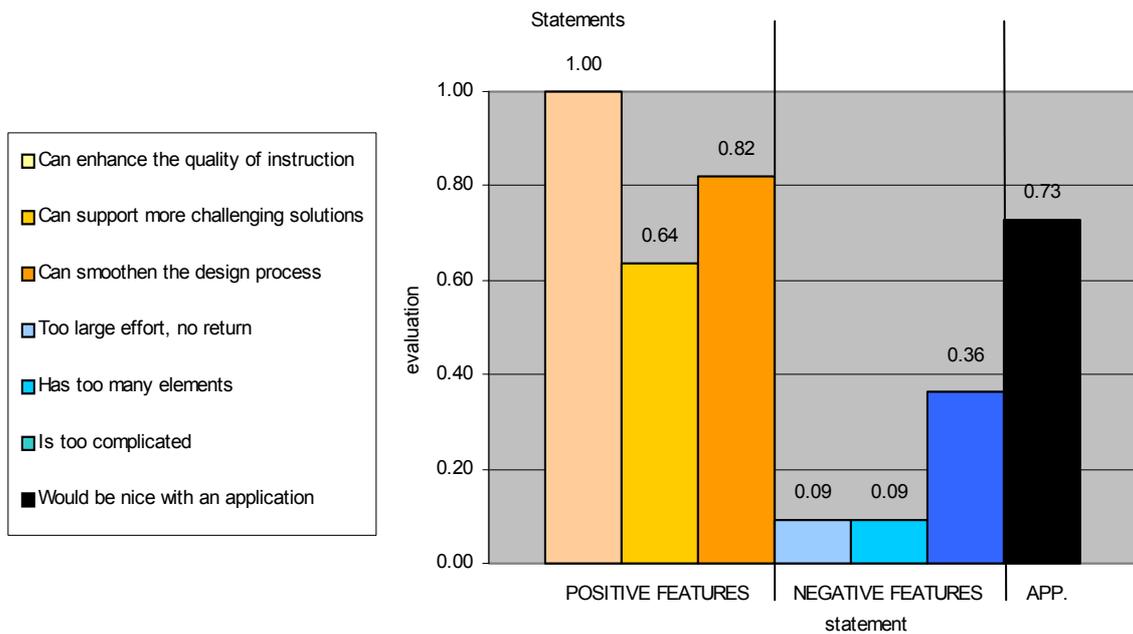


Figure 5.2 - Statement results chart

At a first sight is clear that positive features are felt more correspondent to the reality than negative ones. Remarkably, all designers think that E<sup>2</sup>ML can enhance the quality of the instruction, and a great part of them that it can smoothen the design process. Moreover, only few think that it is too complicated, and a very small part finally thinks that it has too many elements and that the effort eventually spent in learning and using E<sup>2</sup>ML might be too large with respect to the return. The development of an E<sup>2</sup>ML application would then be welcomed by the greatest part of the interviewed designers.

## Who is Using E<sup>2</sup>ML?

Another interesting element to be considered evaluating E<sup>2</sup>ML is who currently uses it, a few months after its first public presentation at the end of June 2003 at EDMEDIA 2003 in Honolulu, Hawaii.

E<sup>2</sup>ML is in use for the design of online courses at the University of Lugano, in the framework of the NewMinE Lab – New Media in Education Laboratory, and the ICeF – Istituto Comunicazione e Formazione (Switzerland), where it has been developed.

The work on pedagogical patterns reported in Chapter IV was done at the DE&T – Distance Education and Technology Department at the University of British Columbia, Vancouver (Canada).

In the same context, E<sup>2</sup>ML is being used for the redesign of a Dentistry course.

E<sup>2</sup>ML was also used at UBC as representation device in a workshop on Instructional Design in August 2003. The participants appreciated very much the use of visuals to explain instructional strategies and their implementation with different delivery technologies.

The topic of pedagogical patterns is also one of the elements within the E-LEN project, and the Technical University in Milano is representing them with E<sup>2</sup>ML. Within the context of the ADAPT project, the same research group is using E<sup>2</sup>ML visualization for modeling adaptive educational applications.

## Summary

Far from a complete evaluation, the goal of this short Chapter is to provide indications for the further development of E<sup>2</sup>ML and for the set up of a complete evaluation of the integration of E<sup>2</sup>ML in the practice of the design of instruction. The data and comments reported above should be read under this perspective.

Designers expressed an overall positive impression about E<sup>2</sup>ML, which they considered an interesting new tool showing potential usefulness for their practice. Within the scope of such a small and limited sample, it is possible to affirm that E<sup>2</sup>ML reaches the greatest part of the goals it was developed for, as they were stated in the Introduction and then refined in the beginning of Chapter II. Synthetically, they can be reprised as follows:

1. Visualization for design:
  - a. Easing and enhancing communication in the design team.
  - b. Defining and expressing the educational requirements of learning materials.
  - c. Supporting quality assessment at design time.
  - d. Supporting a project management approach to course development.
2. Design documentation:
  - a. Creating an archive of the design community.
  - b. Reusing past designs.
  - c. Training novice designers.
3. Reverse engineering and evaluation:
  - a. Identifying instructional issues and figuring out viable redesign solutions.
  - b. Supporting ex-post evaluation.
  - c. Accountability.

The most relevant points that the preliminary evaluation indicates for further work are goals 1d, as a project management approach requires a clear indication of time resources, which should be made more evident in E<sup>2</sup>ML; goal 3a, as the back-tracking diagnosis from design to redesign still presents difficulties. Finally, goal 1b seems to remain out of scope, as the indications E<sup>2</sup>ML may provide to Web programmers or other material development specialists are too general.

Along with the practical indications that emerged, the curiosity that E<sup>2</sup>ML arose, and the designers' will to try it are probably the most significant and relevant results of this preliminary evaluation.

## CONCLUSIONS

# TEACHING, LEARNING AND TOOLS

*“Still (...) it is not objective knowing but human living that is the main point (...). Now there emerge freedom and responsibility, encounter and trust, communication and belief, and promise and fidelity.”*

*(Lonergan 1988, p.219)*

*“Often educators compare the educational enterprise to another activity, that of travel. In such an analogy, the student does the travelling, teachers serve as travel guides, educational goals as destinations, and instructional plans specify the means of transportation and the itinerary. But there is a constant danger inherent in the planning of educational itineraries and the means of transportation; there is much to a journey than the arriving at the destination on time unharmed. People also embark on journeys for the experience of travelling. A trip through France is not undertaken just to arrive in Paris. The French countryside, the French people, the French wine and food, and the enjoyment of a travelling companion are all as important for the success of the journey as the arrival in Paris. Nor should a kindergartner embark on an educational journey merely to receive a high school diploma or to learn the three R's. (...). The educational process should not only accomplish goals but also be human, rational, engaging, enjoyable, and personally gratifying (...). The most compelling reason for this requirement is not that such humane education is most efficient or effective (it may be), but, instead, that schooling constitutes a substantial portion of people's lives and life should be lived in such a manner.”*

*(Posner & Rudnik 1997, pp. 209-210)*

## Summary

The journey of this work started with the definition of some issues raised by new media in Instructional or Educational Design. In order to cope with the increased potential complexity of educational environments, designers need new skills, methods and tools. Starting from such issues, specific goals were formulated for the development of a design language. The selected perspective was design, as different from the institutional, social, technological or economical views on the same issues.

The next step was a literature review in the formal discipline of Instructional Design – in itself an aggregate of several sub-disciplines – that brought to the analysis and comparison of several design models with different scopes (classroom-, product- and system-oriented), which were further organized on different layers (approach, design and procedure). The analysis revealed that the greatest part of models represents the design activity flow, but no language exists for the representation of the object of design, i.e. of the instruction. Educational technology models for learning objects and educational environments were also presented and discussed<sup>1</sup>.

The core of this work was the development of E<sup>2</sup>ML – Educational Environment Modeling Language, a visual tool for the representation of instructional activities, intended as a thinking and communication means. Its formalism is based on an understanding of teaching and learning as a set of variously organized *actions* carried out by *acting subjects* exploiting tools and locations. E<sup>2</sup>ML is not bound to a specific pedagogical approach or learning theory, and its diagrams offer a high degree of flexibility. E<sup>2</sup>ML Core Version is a lightweight tool for design, while the Advanced Version is a more structured and detailed representation, compliant to IMS Learning Design specification.

Along with E<sup>2</sup>ML, the QUAIL model for the classification of learning goals was developed, merging insights from traditional Instructional Design research with new ideas taken from Philosophy – thus following the natural interdisciplinary bent of the former discipline.

A specific Chapter was then devoted to the integration of E<sup>2</sup>ML with other Instructional Design models, to its comparison with learning technologies standards and with flow control languages.

The five case studies and the exploration of the topic of pedagogical patterns provided a glimpse of the possibilities offered by E<sup>2</sup>ML, of its expressive power and of its limitations, and of its actual use in real life situations.

Finally, some indications about the evaluation of such a language and a preliminary collection of data via focus groups and interviews provided some evidence that E<sup>2</sup>ML potentially achieves the greatest part of its goals, and that it is perceived by experienced designers as a promising tool, although it might be improved under several respects.

## Outlooks

The very nature of a language is its being in progress. Any form of expression, from everyday language to art, can be said to be alive as long as it is changing – or better changed by the experience of its “speakers”. Rather than a conclusion, this is therefore an open end, and some of the trails that further research may follow already emerged in the previous pages.

The most important is the implementation of a complete evaluation program, aimed at an assessment of the impact of E<sup>2</sup>ML on design and to its further refinement, and to the definition of eventual adaptation strategies for different design situations. This should also consider the issue of scalability:

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<sup>1</sup> It might have been noticed that, differently from the greatest part of current literature in Instructional Design, Constructivism was not mentioned. It can indeed be regarded as a learning theory, as Cognitivism or Behaviorism, maybe even as an instructional theory, but not as a design model. According to this understanding of Constructivism the topic was not brought in. Nevertheless, E<sup>2</sup>ML can be used for the design of constructivist learning environments.

can E<sup>2</sup>ML be used or extended for unit, course, and program design? Do the three cases require specific expressive devices? Other indications for improvement were already pointed out in Chapter V.

The creation of repositories of case studies and eventually of pedagogical patterns would at the same time benefit from the use of E<sup>2</sup>ML and contribute to its improvement through experience. It would also be interesting to use it for the design of instruction outside the context of Higher Education – maybe considering special needs education or differentiated teaching.

Documenting modes of instruction or strategies can also bring great advantage to projects researching particular types of technologies, such as 3D animations or adaptive hypermedia systems, as E<sup>2</sup>ML can provide a language for describing their application framework.

The QUAIL model could be developed into a grid for the modelling not only of goals but of instructional strategies as well.

Finally, as stressed in Chapter V, the development of an application for supporting design with E<sup>2</sup>ML and QUAIL would be of extreme interest. A detailed analysis of the different ways of doing design of different teams would be necessary in order to get a complete requirement analysis, and the application should provide at the same time a strong consistency support and flexibility. The collaborative and eventually distributed nature of design should also be taken into account. A first demonstrative prototype of graphic interface for QUAIL was already developed within this work, and can be found at <http://www.istituti.usilu.net/botturil/web/e2ml/quail.htm>.

## What About Tzu-gung?

It is now time to look back at the very beginning of the work, when Tzu-gung met the old man in the North regions of river Han.

*As Tzu-gung was traveling through the regions north of river Han, he saw an old man working in his vegetable garden. He had dug an irrigation ditch. The man would descend into the well, fetch up a vessel of water in his arms, and pour it out into the ditch. While his efforts were tremendous, the results appeared to be very meager.*

*Tzu-gung said, "There is a way whereby you can irrigate a hundred ditches in one day, and whereby you can do much with little effort. Would you not like to hear of it?" Then the gardener stood up, looked at him, and said, "And what would that be?" Tzu-gung replied, "You take a wooden lever, weighted at the back and light in front. In this way you can bring up water so quickly that it just gushes out. This is called a draw-well."*

*Then anger rose up in the old man's face, and he said, "I have heard my teacher say that whoever uses machines does all his work like a machine. He who does his work like a machine grows a heart like a machine, and he who carries the heart of a machine in his breast loses his simplicity. He who has lost his simplicity becomes unsure in the strivings of his soul. Uncertainty in the strivings of the soul is something which does not agree with honest sense. It is not that I do not know of such things; I am ashamed to use them."*

(Morgan 1998, p.18)

On page 2, I proposed the draw-well as a symbol indicating new technologies. Now, after the development of a new language, I would like to propose a new interpretation for this very story. This will raise a big issue, as old as Instructional Design. A language is indeed a tool, and the use of a semi-formal language as E<sup>2</sup>ML for design is a technique, a different kind of draw-well, which may in the same way let educators grow a heart like a machine. This legitimate fear of technologies and

techniques, present in almost any field, is more alive in education, where human relationships are in the foreground, and where the growth and maturation of youth are at stake.

A whole essay would not suffice to provide a complete and definitive answer, given that it is possible. I personally believe it is, at least partially, a matter of experience. On the one hand, the more experienced a designer gets with any tool, the more he/she will be able to use it without limitations, or better, taking advantage of them, as the poet does with the limits of language, or the engraver with the limits of her/his technology. On the other hand, only critically evaluated experience will prove, to each single designer, what impact the use of a new tool would have on her/his work, interacting with her/his own way of doing design and with the environment.

This is the reason why the Introduction devoted so large a space to setting the framework for a general understanding of education. It proposed a model for the main step in the dynamic of knowledge, and a definition of teaching as art; then it assessed the role of models in teaching and learning and the continuum between classroom-based and technology-based settings. Education was conceived as the interplay of human relationships as a place where the subject matter, the object of knowledge, can be profitably approached and acquired.

All this may be summarized in the metaphor of the gardener, who plants a seed, takes care of it throughout the Winter, and expectantly waits for the first blossom in Spring. His activity is vital for the new plant, but its life comes from the seed and from the nurturing virtue of the soil, not from the gardener's hands. And he knows that all around the garden, outside its walls, plants and trees are naturally growing everywhere. His hope is that with his knowledge and work, he can raise more delicate and wonderful flowers, or blossoms that could not survive in the wild.

My drive in the development of E<sup>2</sup>ML and QUAIL was that a design language might improve the quality of design and the practice of sharing ideas in a design team, as well as among different teams. I also believe that this may enhance the quality of education in many contexts. And the whole point is not education as such, but the human quality of life for people who can receive a good education – as the quote that opens this conclusion states, education is not about teaching and learning, but about human living.

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## APPENDIXES

## A. Bernard J. Lonergan: Bibliography

University of Toronto Press publishes the series *Collected Work of Bernard Lonergan* in co-operation with the Lonergan Research Institute of Regis College, University of Toronto. The series includes all of Lonergan's published works, a number of previously unpublished items, and translations of his most important Latin volumes. It will eventually consist of 21 volumes and an index.

- *Grace and Freedom: Operative Grace in the Thought of St. Thomas Aquinas*. Edited by Frederick E. Crow and Robert M. Doran (2000).
- *Verbum: Word and Idea in Aquinas*. Edited by Frederick E. Crowe and Robert M. Doran (1997).
- *Insight: A Study of Human Understanding*. Edited by Frederick E. Crowe and Robert M. Doran (1992).
- *Collection: Papers by Bernard J.F. Lonergan*. Edited by Frederick E. Crowe and Robert M. Doran (1993).
- *Understanding and Being: The Halifax Lectures on Insight*. Edited by Elizabeth A. Morelli and Mark D. Morelli (1990).
- *Philosophical and Theological Papers, 1958-1964*. Edited by Robert C. Croken, Frederick E. Crowe, and Robert M. Doran (1996).
- *The Ontological and Psychological Constitution of Christ*. Edited by Michael G. Shields, Frederick E. Crow, and Robert M. Doran (2001).
- *Topics in Education: The Cincinnati Lectures of 1959 on the Philosophy of Education*. Edited by Robert M. Doran and Frederick E. Crowe (1988).
- *Macroeconomic Dynamics: An Essay in Circulation Analysis* (1999).
- *Phenomenology and Logic: The Boston College Lectures on Mathematical Logic and Existentialism*. Edited by Philip J. McShane (2001).
- *For a New Political Economy*. Edited by Philip J. McShane (1998).
- *A Second Collection*. Edited by William F.J. Ryan and Bernard J. Tyrell. First Published in 1974.
- *Method in Theology*. Second edition. First Published in 1973.

Forthcoming editions:

- *Early Works on Theological Methods I*
- *Early Works on Theological Methods II*
- *Early Latin Theology*
- *A Second Collection (new edition, originally published in 1974)*
- *Method in Theology (new edition, originally published in 1973)*
- *A Third Collection*
- *The Incarnate Word*
- *The Triune God*
- *Philosophical and Theological Papers, 1965*
- *Shorter Papers*
- *General Index*

For a complete bibliography see <http://www.lonergan.on.ca>.

## B. Acronyms

ABCD: Audience, Behavior, Conditions, Degree (ASSURE's guidelines for behavioral objectives)  
ADDIE: Analyze, Design, Develop, Implement, Evaluate  
ADL: Advanced Distributed Learning  
AICC: Aviation Industry CBT Committee (see below for CBT)  
API: Application Program Interface  
ARCS: Attention, Relevance, Confidence, Satisfaction  
ASSURE: Analyze learners, State objective, Selects methods media and materials, Utilize media and materials, Require learner participation, Evaluate and revise  
CADMOS-D: Courseware Development Methodology for Open instructional Systems Design  
CAI: Computer Aided Instruction  
CBS: Course Breakdown Statement  
CBT: Computer-Based Training  
CDT: Component-Display Theory  
CMI: Computer Managed Instruction  
DE&T: Distance Education & Technology (Department of UBC – see below)  
DTD: Data Definition Document  
EE: Educational Environment  
ETHZ: Eidgenössische Technische Hochschule Zürich  
ID: Instructional Design  
IEEE: Institute of Electrical and Electronics Engineers, Inc.  
IMS: Instructional Management Systems project  
IT: Information Technology  
HTML: Hyper-Text Markup Language  
HDM: Hypermedia Design Model  
LMS: Learning Management System  
LOM: Learning Object Model  
LTSC: Learning Technology Standardization Committee (IEEE committee)  
MMM or 3M's: Methods, Media and Materials (within ASSURE)  
OO: Object-Oriented  
PPPPP or 5P's: Preview the materials, Practice the presentation, Prepare the environment, Prepare the audience, Present the materials  
RDCEO: Reusable Definition of Competency or Educational Objectives  
RTSI: Radio Televisione della Svizzera Italiana  
SCORM: Shareable Content Object Reuse Model  
SME: Subject Matter Expert  
TDEE: Technology-Dependent Educational Environment  
UBC: University of British Columbia  
UML: Unified Modeling Language  
UNIVELS: *Universitas Veritas and Libertas Sapientiae*  
UNO: United Nations Organization  
USI: Università della Svizzera italiana (University of Lugano)  
W2000: Web 2000 (the follower of HDM)  
XML: eXtensible Markup Language

## C. Designer's Feedback Form

### ABOUT E<sup>2</sup>ML

1. WHAT IF...	YES	NO	Comments
You are in the development team for a course in Economics along with a faculty, a subject expert from the corporate world and a Web programmer. It looks like you talk different language and it is not easy to understand each other. <b>Would E<sup>2</sup>ML enhance internal team communication?</b>			
You are tight on schedule with a course, and you run to the Web programmer for having things online in the next few days. Unfortunately, the Web programmer is on holiday – you find a newly hired guy to replace him. <b>Would E<sup>2</sup>ML support Web material development, and support the new guy in understanding what you want him to do?</b>			
The authors of a course have decided to use a mixed face-to-face and online strategy, which is also new for you under some respect. <b>Would E<sup>2</sup>ML support checking if the course would work as one consistent whole before trying it with real student (quality assessment at design time)?</b>			
A course requires the intervention of tutors in a number of different activities. It looks like they will be working very hard. <b>Would E<sup>2</sup>ML help detecting work overload time spans tutors?</b>			
A course did not work – a lot of students drop out. <b>Would E<sup>2</sup>ML serve as a diagnostic tool and identify what to redesign?</b>			
Last year you developed a successful course, and the President want it replicated this year. The problem is that the materials should be updated, and the original author has retired. <b>Would the E<sup>2</sup>ML documentation help working with the new author for reusing/readapting the instruction?</b>			
In the same situation as above, <b>what if the same course, with the same author, is offered to a different target (e.g. students from a different Faculty)?</b>			
You meet a colleague from Louisiana, and you discuss with him the way you do courses. You say you try to be constructivist, and the same says he. But going on you actually disagree on a number of practical decisions in course development. <b>Would E<sup>2</sup>ML be useful for more effectively comparing designs and courses?</b>			
<b>Would the E<sup>2</sup>ML documentation be useful for checking the implementation status of a course?</b>			
A new young course developer is hired at DE&T. You are asked to mentor him and teach him some tricks. <b>Would E<sup>2</sup>ML representation of courses be useful to let her see the way you do your job and the types of decisions you take?</b>			

## 2. Statements

Here are some statements about E<sup>2</sup>ML. Check all that apply (write an X beside them)

- E<sup>2</sup>ML can enhance the quality of instruction
- E<sup>2</sup>ML is too complicated
- E<sup>2</sup>ML can support the implementation of more challenging design solutions for education
- E<sup>2</sup>ML has too many elements
- E<sup>2</sup>ML can smoothen the design process
- The effort E<sup>2</sup>ML requires in writing the documentation is not rewarded anyway
- E<sup>2</sup>ML would be nice if it could be used with a software application

## 3. Other Comments

Please write here any other comment about E<sup>2</sup>ML.

## 4. Contacts

Can you suggest me the email of other people who might provide some feedback about E<sup>2</sup>ML?

**Thanks for your contribution!**

## **D. Institutional Profiles**

### **University of Lugano, Faculty of Communication Sciences**

The University of Lugano (Università della Svizzera italiana-USI) was founded in 1996. As a public institution independent of state control, it joined the nine cantonal universities and two federal institutes of technology that form the Swiss university system. It distinguishes itself as the only university outside Italy where the official language of tuition is Italian.

Today, USI comprises three Faculties: Economics and Communication Sciences in Lugano, and Architecture in Mendrisio, for a total student population of approximately 1500 from 35 different countries, and a total teaching staff of 300 professors and assistants. Plans for a new Faculty (Computer Science) are already well under way.

Benefiting from a unique geographic, political, and cultural location, USI has gained distinction as a multilingual and multicultural university, with a broad international outlook. It enjoys privileged relations with several Italian universities, particularly with those located in Northern Italy, and has built special collaborative or exchange partnerships with a number of foreign universities in Europe and elsewhere. USI has an agreement with two renowned academic institutions in Milan, for the award of a 'double degree' (doppia laurea), in Economics with one (Università Bocconi) and in Architecture with the second (Politecnico). A period of practical training (internship) is an integral part of the undergraduate curriculum in general: thus by fulfilling this requirement, with a firm, institution or organisation in Switzerland or abroad, undergraduates contribute to promoting the image of a university open to the 'real' world of work.

Small size, direct student-teacher contact, fruitful synergies between the different disciplines (the humanistic, the socio-economic, and the technological), but also ample classroom and laboratory space as well as top-quality equipment and facilities: USI offers the ideal premises for the pursuit of learning and research.

It is in situations where diverse languages, cultures and political and economic organisations come together thereby generating exchange, hence innovation that communication truly matters and comes into its own. The unique position of the University of Lugano (Università della Svizzera italiana-USI) in Canton Ticino where different linguistic, cultural and political areas converge has quite naturally reinforced the *raison d'être* of the Faculty of communication Sciences as a privileged centre for multilingual and multicultural teaching and research.

The study programme of the Faculty of Communication Sciences aims to prepare and create specialists operating in the major professional contexts: media, businesses, institutions, schools, and information technology. The Faculty is the only one in the Swiss university world to offer a broad-spectrum education and a fully interdisciplinary approach, which integrates economic, humanistic, sociological, and technological teachings.

(Taken from [www.com.unisi.ch](http://www.com.unisi.ch))

### **DE&T, University of British Columbia, Vancouver**

Distance Education and Technology (DE&T) is a division of Continuing Studies at UBC, which develops and delivers credit courses and professional programs in collaboration with the Faculties and academic departments on campus. DE&T courses are available to students from UBC, B.C.'s Open University and others via partnership agreement.

The courses are developed and designed by a team of people, including an expert in the subject matter. This means that courses are designed to be comprehensive, yet flexible enough to allow for modifications as needed.

Each year DE&T works with the UBC Advisory Committee on Distance Education to approve funding for the development of new or revised courses for distance delivery. This committee has representatives from all 12 UBC faculties, Continuing Studies and various service departments as the UBC Library. Funding includes release time for faculty. Courses are developed through a strong project management model, requiring a fully costed course proposal and a formal letter of agreement between the academic department and DE&T. For each course, DE&T provides a course developer who acts as a project manager and instructional designer, and who is the main contact for the subject expert from the academic department. The course developer draws on specialist staff in marketing, web design, graphic design, digital production and learner support.

Courses are delivered in various formats, including:

- Online with opportunity for collaboration and interaction with other students and instructor: not independent study.
- Print materials: independent study with instructional guidance.
- Print materials with teleconference meetings between instructors and students.
- Print materials including supplementary learning materials such as videotape, audiotape, CD-Rom.
- Print materials with a web component for on-line discussion with other students and instructor.
- Fieldwork/labs, clinical component.

Typically, instructional support for courses delivered through DE&T is available in two formats:

- Computer – students and instructors communicate using email and/or on-line discussion forums and assignments are submitted by mail, email or through electronic drop box in the course website.
- Telephone – students and instructors communicate by phone and assignments are submitted by mail.

(Adapted from [det.cstudies.ubc.ca](http://det.cstudies.ubc.ca))

## Univels

Univels è una università interattiva a distanza, in particolare (grazie a borse di studio) anche per le fasce più povere della popolazione dei paesi in via di sviluppo (PVS)

In che consiste?

1. Corso di Laurea triennale a distanza in Tecnología en gestión empresarial (analoga ad Economia aziendale), legalmente riconosciuto dal Ministero dell'Educazione colombiano, secondo la metodologia educativo-didattica innovativa UNIVELS, brevettata dall'Associazione Monserrate ONLUS, basata sull'alta tecnologia informatica di comunicazione via videoconferenza, che permette lo svolgimento di lezioni interattive in sincrono da parte di Professori europei e utilizza una piattaforma educativa di distance-learning.
2. Specializzazioni. Terminati i tre anni si potrà finire il corso di laurea in Italia o in Colombia con specializzazioni riconosciute dal Ministero dell'Educazione in Colombia e dal Ministero in Italia. La prima sede dell'Università è stata realizzata nella città di Bogotá, presso il Centro "San Riccardo Pampuri", zona 4 (San Cristóbal), zona poverissima alla periferia della capitale colombiana. Sono attualmente attivi ulteriori punti di trasmissione in Bogotá e nelle città colombiane di Armenia e Cartago. Si prevede l'apertura di altri punti in Panamá, Perú, altri paesi in America Latina sia per il corso di laurea breve che per le specializzazioni.

A chi si rivolge? Univels si rivolge a giovani con scarse o nulle risorse economiche. Per l'alto livello accademico, si rivolge a studenti che vogliono studiare con la qualità delle università europee e, allo stesso tempo, a studenti privi di risorse economiche che vivono nelle periferie più povere e degradate

delle megalopoli dei PVS. Per questo si sta organizzando un sistema di borse di studio per finanziare i giovani che volendo studiare, mancano delle risorse necessarie. Il progetto nasce dal desiderio dell'Associazione Monserrate ONLUS ([www.associazionemonserrate.org](http://www.associazionemonserrate.org)) di creare opportunità di sviluppo nei PVS e condizioni di dialogo e condivisione di esperienze fra culture e popoli differenti.

(Adapted from [www.associazionemonserrate.org](http://www.associazionemonserrate.org))

## **Eurocol**

Eurocol, Fundación Eurocolombiana de Educación Superior, es una institución de educación superior de derecho colombiano, que por su innovadora metodología didáctica “UNIVELS”, da acceso al mejor nivel educativo mundial.

Cómo nace el método? La base del método de enseñanza Eurocol, es:

- Aprovechar al máximo los avances tecnológicos para la formación académica
- Ofrecer a los estudiantes colombianos, la calidad educativa impartida en los países que están a la vanguardia en técnica y ciencia, mejorando así el nivel de nuestros profesionales.

Diseñado en Europa por la red científico-cultural internacional UNIVELS, este método se hace presente en Colombia con Eurocol.

(Adapted from [www.eurocol.edu.co](http://www.eurocol.edu.co))

## E. E<sup>2</sup>ML Add-in for Rational Rose

E<sup>2</sup>ML is not aimed at producing *machine-readable code* but at providing a sharable “user friendly” set of visual tools for the design of educational environments. The E<sup>2</sup>ML Rational Rose Add-In has been developed in order to provide a software support for E<sup>2</sup>ML mapping of educational environments, in UML notation.

Rational Rose is the world most used visual tool for *object-oriented* analysis, modeling and design. It includes a suite of tools that help the design of client-server and distributed software solutions using a thorough UML notation.

Despite it is not the only available UML tool, Rational Rose fits the requirements of this work because of the Rose Extensibility Interface (REI) that allows other customized applications to be embedded in the main program, amplifying its possibilities and getting closer to the user requirements. The REI consists of a collection of functionalities that allows to change the either the aspect or the behavior of Rose and to exchange data with other applications using the Component Object Model system. The applications that extend Rose interfacing with the REI are called add-ins. The add-in consists in a series of Visual Basic developed forms that allow the insertion of the “environmental” data into customized Class Diagrams.

The E<sup>2</sup>ML add-in relies on a custom form for *actions* (see below).

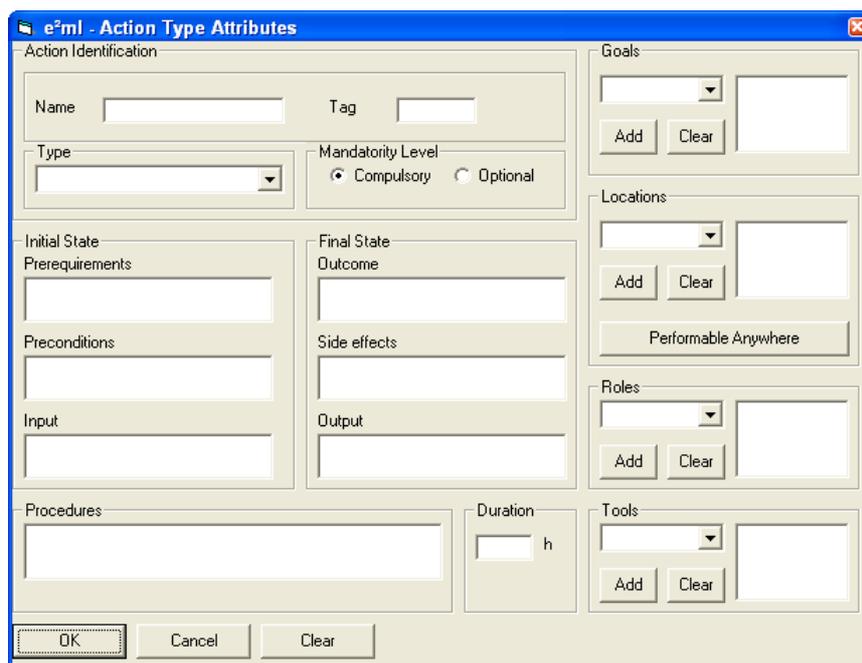


Figure A.1 - E<sup>2</sup>ML Rational Rose add-in: action diagram form

Moreover, Rational Rose can be customized quite in depth, as it actually allows the user to create a framework with a set of pre-ordered UML items. Thus a proper framework has been created in order to increase usability and make dynamic as many design steps as possible.

Every different E<sup>2</sup>ML document set has been assigned a package maintaining the E<sup>2</sup>ML denominations.

Also the toolbar has been modified in order to be E<sup>2</sup>ML-compliant: it does not contain elements that do not belong to the language, thus reducing the “icon overcrowding” and increasing the consistency

by removing undesired items. The Figure below shows the E<sup>2</sup>ML Rose workspace (left) and the standard Rose workspace (right).

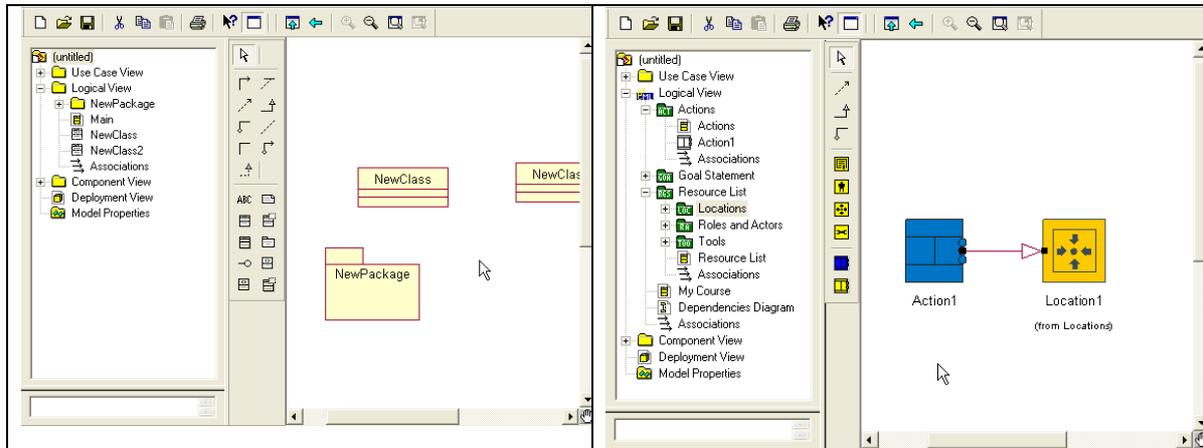


Figure A.2 - E<sup>2</sup>ML Rational Rose add-in: workspaces comparison

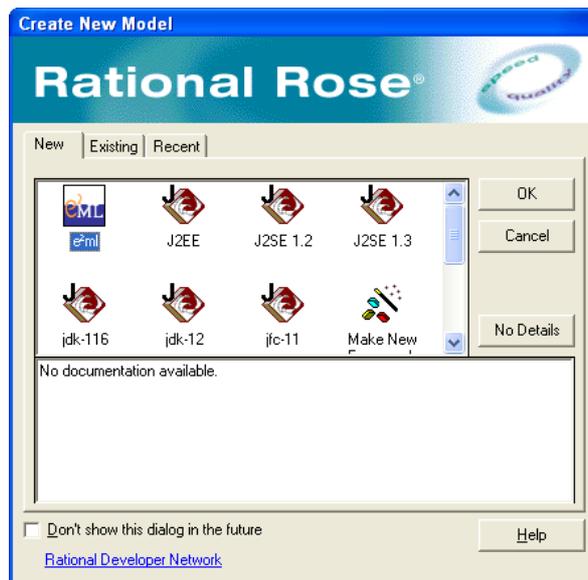


Figure A.3 - E<sup>2</sup>ML Rational Rose add-in: framework selection

A typical model produced with Rational Rose and the E<sup>2</sup>ML add-in will consist of:

1. A set of Class Diagrams for the Goal Statement, the Resource Lists and the Action Diagrams.
2. A Collaboration Diagram associated to the E<sup>2</sup>ML Dependencies Diagram.
3. An Activity Diagram for the Activity Flow.

Rational Rose is a visual tool: it means that the (big) amounts of “environmental” information cannot be directly displayed in the UML schemas that are supposed to show mostly the interactions among the items.

In order to produce an easy-to-read documentation (as close as possible to the E<sup>2</sup>ML design style) the user will have to filter a Report from the model file using the Rational SoDA software. This will create a Microsoft Word document containing the UML graphics and all the inserted data in a tabular form. For example such an important device as the QUAIL grid could not be developed in a strictly UML

software environment, so it has was implemented in the SoDA template as a MS Word table linked to the data stored in those classed stereotyped as “Goals”.

In order to run and use the add-in he final user will only need the following programs:

1. Rational Rose Enterprise Edition.
2. Rational SoDA for Microsoft Word.
3. Microsoft Word (for creating printer friendly documentation).

(Adapted from Saluzzi 2003)

## F. Publications related to E<sup>2</sup>ML

This is a comprehensive list of publications related to the content of this work, updated to August 2004, nine months after the discussion of this Ph.D. thesis.

### About E<sup>2</sup>ML

- Botturi, L. (2004). Visual Languages for Instructional Design: Evaluating the Perceived Potential of E<sup>2</sup>ML. *EDMEDLA 2004*, Lugano, Switzerland
- Botturi, L. (2003). E<sup>2</sup>ML - A Modeling Language for Technology-dependent Educational Environments. In *EDMEDLA 2003*, Honolulu, Hawaii.
- Botturi, L. (2002). E<sup>2</sup>ML - A Modeling Language for Technology-dependent Educational Environments. In *Studies in Communication Sciences* [special issue on New Media in Education; outline of this research].

### About QUAIL

- Botturi, L. (2004). Visualizing Learning Goals with the Quail Model. *Australasian Journal of Educational Technologies - AJET 20(2)*, 248-273.
- Botturi, L. (2002). Knowledge as Relationship and E-Learning. In *ELEARN 02*, Montreal, Canada [this is a preparatory study].

### About pedagogical patterns and E<sup>2</sup>ML

- Belfer, K. & Botturi, L. (2004). Online Learning Design with Pedagogical Patterns. *SALT Orlando Conference 2004*, Orlando, Florida, USA
- Belfer, K. & Botturi, L. (2003). Pedagogical Patterns for Online Learning. In *ELEARN 2003*, Phoenix, Arizona.

### About the Istituzioni 1 and Istituzioni 3 case study

- Botturi, L., Inglese, T. & Rozalèn, S. (2003 a). The New Media Juke-Box: a Multimedia Project. In *EDMEDLA 2003*, Honolulu, Hawaii.
- Botturi, L., Inglese, T. & Rozalèn, S. (2003 b). Design and Trust as Key Factors in E-learning. In *SITE 2003*, Albuquerque, New Mexico.
- Botturi, L., Inglese, T. & Rozalèn, S. (2003 c). MJB: a Web Application Case Study. In *ICNEE 03*, Luzern, Switzerland [poster session].
- Botturi L. (2002 b). The New Media Juke-Box. In *ELEARN 02*, Montreal, Canada, [interactive session].

Chapter I was reviewed and published as Botturi, L. (2003). Instructional Design and Learning Technology Standards: an Overview. ICeF - Quaderni dell'Istituto.

Another article summing up the work about E<sup>2</sup>ML with more recent works is currently in the review process for *Educational Technology Research and Development*.