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INSTRUCTIONAL DESIGN & LEARNING TECHNOLOGY STANDARDS: AN OVERVIEW

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Introduction

This report is devoted to presenting some of the most referenced Instructional Design models and the up-to-date state of the definition of learning technology standards. Its goal is not to offer an exhaustive summary of the discipline or of the field of educational technologies¹, but to provide a first critical introduction into the design of education taking into account both perspectives, namely the educational and the technological. This means providing access to the tradition and the tools of Instructional Design, a discipline that is often underestimated in the teaching practice of many European schools, and to the emerging field of learning standards, which still remain unknown to most educators.

We will present the main areas and trends along with the necessary reference, while each of the selected models is to be intended as an example of a broader category. Both Instructional Design and learning technology standards express their contribution to education as *models*, i.e. representations of states, objects or activities. We understand models to be tools that can be used for solving specific problems, and we approach them here with this spirit. The models presented are in fact tools developed for helping instructors, designers and learners to achieve better results in teaching and learning.

According to its goals, this report does not provide an historical perspective on Instructional Design². This would be very interesting, not only from the perspective of the history of science, but also from that of the history of ideas. As we already mentioned, the development of (design) models is indeed always strictly related with the development of concepts, in our case with the evolution of the ideas of education, culture, school, etc. Also the re-contextualization of existing models into a new conceptual framework is another interesting and always ongoing process in this discipline.

The report is structured into two main sections. The first section presents the core of Instructional Design models, using the classification proposed in (Gustafson & Branch 1991) as red-thread. Learning technology standards are integrated in such a view, trying to figure out how they will affect the instructor's and the designer's work. The second section focuses on the definition of learning goals – a key activity in the design of education that presents several relevant issues³.

¹ A more exhaustive summary can be found in (Gustafson & Branch 1991) and (Gustafson & Branch 1997).

² A red-thread for such analysis could be found in (Gustafson & Branch 1997).

³ This report is an intermediate result of the author's Ph.D. research, which consists in the development of a representation language for educational environment design. The work is done at the School of Communication Sciences at the Università della Svizzera italiana under the direction of prof. Marco Colombetti. The research was also supported by the New Media in Education – NewMinE doctoral school, funded by the FNSRS.

What is Instructional Design?

Smith and Ragan defined instructional Design 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)

We chose this definition as it expresses in a clear manner the relationship between design and principles. Nevertheless, it does not include, at least explicitly, all the three elements or sub-disciplines in which Instructional Design is classically organized, and that will be introduced and discussed in the following paragraphs.

The IEEE provides another definition:

“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)

This second 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 particular instructional solutions in particular cases.

What are Instructional Design Models? A Stress on Method

“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 labeled instructional development models) are models *of the design process itself*.

This is worthwhile as it 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; a Physicists models the particles he is studying; the instructional designers use models that describe not the object of the design but the design process that should be performed for increasing the chances to produce high-quality instruction.

The cause for this particular approach is surely historical, but also correspond 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)

It is therefore a stress on method, more than on the object itself. 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 greatly 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 of Instructional Design.

In order to define the virtual space of Instructional Design we will introduce three variables for classifying them:

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

Three Sub-disciplines

Instructional Design

The first element or sub-discipline is instructional design, which gives the name to the discipline itself, and that is its core part⁴. It is the element that the IEEE definition points out, when it uses the verb “determines”.

By instructional design we mean the pure design process, i.e. the conception of the educational activity as a solution to a particular problem. By educational activity, at this level, we understand the definition of 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 that actually *in rebus*.

Instructional System Development

The plan of educational activity produced by instructional design is then to be implemented as a real educational environment: all the single elements have to 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 of much narrower 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, interactive software, classrooms, trained tutors, etc.

Instructional Design and Learning Theories

The last element in the structure of Instructional Design is the one underlined by Ragan and Smith’s definition, “translating 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 is

⁴ For avoiding ambiguities, we will refer to the discipline as Instructional Design (uppercase), while instructional design will refer to the particular activity and sub-discipline.

education, 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 by men with a specific idea of education, which is indeed reflected in their contribution to Instructional Design. Nevertheless these models (or at least the greatest part of them) are tools that can be used almost independently from their creator's idea of education. 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 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 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.

So, can any theoretical research in education be included in the toolbox of Instructional Design? Not any, as not all theories have practical implications, or can be used to suggest guidelines for design⁵.

Three Layers

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

Approach

Richards and Rodgers define *approach* as to “refer 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, the objective and general pedagogical principles along with philosophical and epistemological beliefs concerning the very nature of the subject matter, the kind of knowledge addressed and education as such. 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”.

Design

The design level includes the actual design of the course, with the definition of specific sub-goals and of the main didactical roles, activities, settings, etc. This layer transforms the approach layer into particular design choices, and at the same time provides an input

⁵ In this sense, it is extremely interesting to read Ragan & Smith's discussion of Constructivism.

for the procedure layer. On this layer we can decide to foster trial-and-error learning and to realize a course website for accessing all course materials, or we 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”. 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 a role-playing setting for group work, or the detailed specification of the course website.

The three layers define the space within which the course design process takes place and are strongly interconnected, each of them providing the input for, or influencing, the next layer.

It is important to point out 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 course designer should interpret decisions on one layer, and is in charge to perform sensible choices in order to define those on the next layer. 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 his/her ability and understanding of the situation. This is what makes teaching and course design more an art than an engineering process: it surely relies on several scientific results from psychology and cognitive science, but still depends on the personal capacity and free risk-taking choice of teachers and designers.

Generally speaking, Instructional Design models mainly address the layers of design and procedure, but some of them have hidden or evident implications that belong to the level of approach.

Scope of the Models

In order to present models in a systematic way, we will frame them 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. Moreover, a different entity of resources should be invested in relation to the granularity of design.
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 managing his/her own course.
4. *Instructional design skill or experience required.* While some models are suitable to beginners, others are of greater complexity and can be used profitably only with adequate design skills.
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.* As we already mentioned introducing the activity of instructional design, analysis is one of the key points. According to the typical situation for which the model was originally developed, a different amount of analysis or need 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 – we are here clearly referring to prototypes 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 define three categories of Instructional Design models, which are “three different perspectives from which Instructional Design models can be viewed” (Gustafson and Branch 1997 p.78):

1. Classroom-oriented models:
2. Product-oriented models:
3. System-oriented models:

The specific definitions provided by Gustafson and Branch are reported in Table 1:

	Classroom-oriented	Product-oriented	System-oriented
Typical output	1 to few hours	Learning material	Course/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 - Taxonomy of Instructional Design models, adapted from (Gustafson & Branch 1991)

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 is the designer, what is he trying to develop, 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)

Instructional Design Models

The three sub-disciplines, the three layers and the scope will serve as a general grid for classifying Instructional Design models. The presentation outline will follow Gustavson & Branch's scope of the model distinctions, as it is the most common in the literature.

General Design Guidelines

The spread of the Internet and of new media has produced the flourishing of a number of books offering guidelines to teachers willing to integrate the new tools in their job. These texts cannot be included with full right in any of the categories we introduced above, nor can be said to be part of Instructional Design.

The situations these texts address is that of a lone-ranger teacher, who is in charge of a whole course from A to Z, and do not consider the profile of the instructional designer. This is interesting as it reveals their narrower scope. Moreover, 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 approach can be found, and the teacher's impression is often that of a too high demand on his/her 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.

All the same, they are worth mentioning as they represent a sort of *vulgata* of Instructional Design, and they often wrap-up suggestions and indications from different models, mingled with the author's experience, into one whole "list of things to care" for teachers.

Some examples are (Schweizer 1999) and (Mc Cormack & Jones 1997). Some of these books renounce to respond to all the issues raised by new media in education and prefer focusing on one peculiar aspect, such as (Mc Connell 2000) does in his interesting book on Computer-supported Collaborative Learning mingling research results with practical guidelines.

Classroom-Oriented Models

Classroom-oriented models are a structured approach to our 80s university professor's teaching activity. They 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 (which is indeed an advantage in any situation!). 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 supposedly low. Reuse is also often not a central issues in these models.

In short, it is the classical brick-and-mortar situation, where usually all teachers are able to survive. So, why are they part of Instructional Design? Historically, the reflection on the simple educational situation has give birth to simple models that have been afterwards taken as backbone of more sophisticated structures considering more complex issues.

The general focus of classroom-oriented models is on the design activity and on the design layer, although the development activity and some indication about the procedures may be a matter of concern. Specially, the distinction between design and procedures – which is naturally blurred – is not clearly assessed by these models: the guidelines they provide are left to the designers for application, and can usually be generalized to design or specified to procedures.

ADDIE

ADDIE is the standard basic model for almost all Instructional Design. It is referenced in several documents proposing standard design processes, such as in (IEEE 2001) and (AskERIC 1999).

ADDIE stands for

- Analyze
- Design
- Develop
- Implement
- Evaluate

The five phases are sketched in Figure 1.

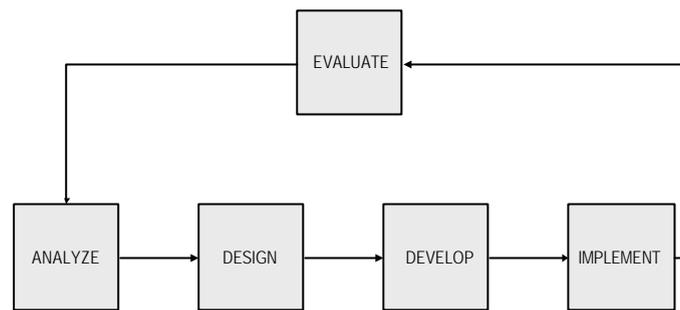


Figure 1 - the ADDIE model

A first glance reveals two important features of this model that are common to all Instructional Design models.

1. The process starts with analysis, not with design. The importance of such an activity (which in classroom-oriented models is not so relevant as it is in models with a wider scope) is paramount and evident for anyone used to practice any kind of design. Nevertheless, often designers start believing that the situation is clear enough, 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 – we will see what in a few lines.
2. The design activity is cyclic. Once the course is over, the process – and the designer’s work – is not. Instructional Design poses a great stress on learning from experience, assessing the results and improving over time.

These features are common to all Instructional Design models, as well as the core elements of all models, tailored to specific kinds of situation, are basically variation on the ADDIE theme. The five phases are presented in the following paragraphs. According to its nature of general model, ADDIE does not provide specific tools or methods for the single phases. The stress is here rather on the actual existence of phases, and on their order.

Analyze

The analysis phase consist in gathering information about the learners, the learning context and the expected learning activity. The elements to be considered are

1. The learning goal(s)
2. The nature of learners (age, previous knowledge, previous learning experience, attitude toward learning)

3. The learning context (location, accessibility, facilities, time schedule, etc.)

Design

The design phase considers first the analysis of the content to be taught and its division into chunks, or sub-topics. According to a selected strategy, the actual lesson planning should be developed: what content should be presented in what form, and through what activity.

Also in this phase the delivery media (classroom, asynchronous Web site, videoconference, VHS videotape, etc.) and the learning materials are selected. By these decisions, several constraints come into play: 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 a 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 is the thorough evolution and completion of the design phase: it is the process of creation and testing of the learning experience in all its components.

This means arranging the selected materials to 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 the actual learning experience is often encountered in other models as *external* to the design process, as something that happens afterwards. As we will see, the implementation is taken over by testing and review.

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 this is the input experience for the next phase

Evaluate

Evaluation is of paramount importance as it is the phase that 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.

The simple consideration that evaluation is a core part of the design process 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 (e.g. included in the test or a specific wrap-up of the online forum interaction, etc.).

Did it 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 directly to all the other four 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 2:

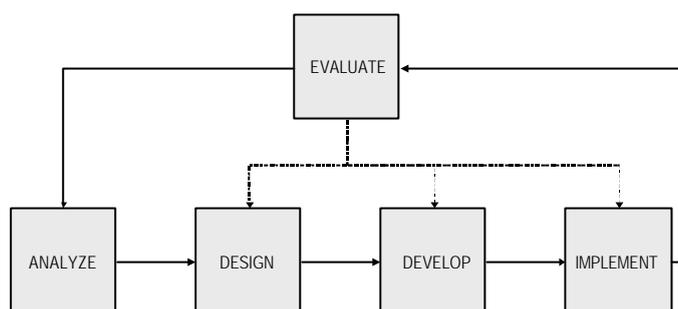


Figure 2 - The ADDIE model revised

The ADDIE model presents a general and generic structure for Instructional design and, as we have said, is used as a backbone for a great number of models, that add to it further specification and some particular methods for the single phases.

ASSURE

Developed by R. Heinich, M. Molenda and J. Russel (1993), the ASSURE model is an enriched evolution of the ADDIE general model. Although they are now six and not exactly corresponding to ADDIE's five, ASSURE also presents design phases, and shares with it the 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 & Russel 1993, p.31) – its main perspective is on how to integrate media, any kind of media, into instruction in a proper and effective way in terms of learning outcomes.

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, the authors of ASSURE propose also specific checklists for each phase, that are 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. *The students' learning styles* should also be considered, as the instruction should be valid for different preferences. The learning style is a personal feature of each learner's, and it is difficult to be assessed. Learning styles are an open and vivid area of research, and can be classified in different ways. We provide here a general outline along with the references to the main authors. A general distinction considers four basic styles as sensory preferences (visual, auditory, tactile, kinesthetic). Kolb's Learning Style Inventory (Kolb 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 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's model of information processing (Gregorc 1979), according to which there are two main dimensions (abstract vs. concrete and sequential vs. random) that generate four possible information-processing preferences (see Figure 4).

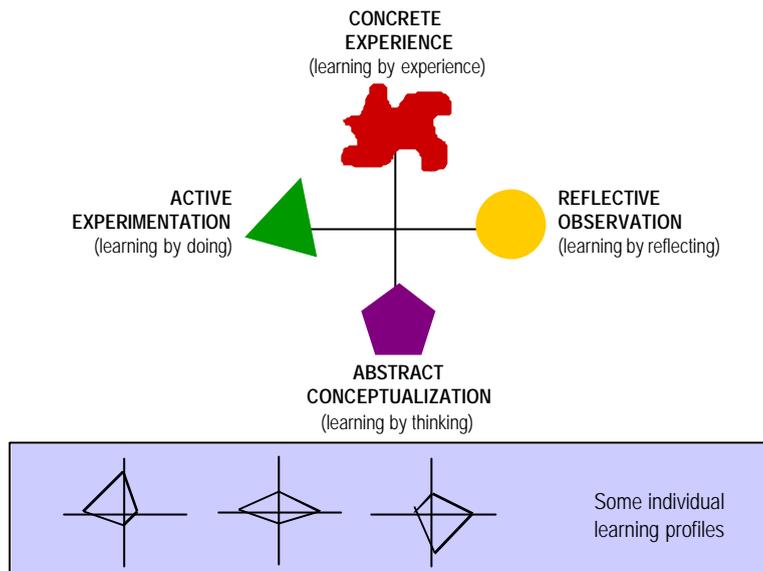


Figure 3 - A representation of Kolb's learning Styles (taken from Kolb 1999)

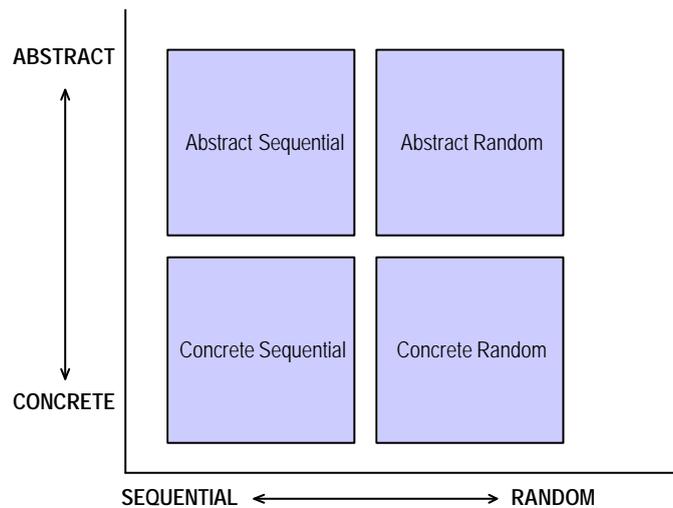


Figure 4 - Gregorc's information processing styles

State Objectives

After an accurate analysis of the target learners, the ASSURE model introduces a novelty with respect to ADDIE: the explicit definition of learning objectives. Within ADDIE, this was included in the Analyze phase. ASSURE emphasizes this aspect by assigning this activity a specific place. The explicit statement of objectives is indeed an important, deciding and difficult phase in the instructional design process.

One great difficulty with learning objectives is that they must be somehow related to the evaluation. Moreover, both learners and teachers should be evaluated on the basis of the achievement of the objectives. One possible solution is the one proposed here: learning objectives should be specified as behavioral objectives, i.e. 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, in the same discipline, we think of “possessing a correct concept of *particle*”: the only way to observe something is letting the learner produce a verbal definition of it. But does this mean he/she 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, which will be discussed thoroughly in the last part of this report. ASSURE proposes ABCD, a sub-model for correctly expressing behavioral objectives. As usual, it is an acronym, and stands for:

- Audience: what learners are the target for the objective (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).

Within the ASSURE model, 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

Now that the situation was analyzed and the goals are clearly expressed in terms of expected behavioral outcomes, the designer’s activity focuses on the instructional activity itself. This is done by selecting the methods to be used, the delivery media and the learning materials, and corresponds to ADDIE’s Design and (partially) Development phases.

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; his/her task is rather to select the best solutions among existing opportunities.

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).

The criteria indicated for the selection concern 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, the designer is not obliged to select just one element for each category. A unit of instruction may switch among different methods and combine more delivery media with several materials, according to the designer's practical creativity.

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.

Before the enactment, that the designer has to pass through another sub-acronym: PPPPP (or the 5P's), which stands for:

- Preview the materials: they should not just be ready, but the instructor should master them completely, technically and as content, in order to avoid any inconveniency.
- Prepare the materials: the materials should be adjusted, sequences, eventually copied, distributed, etc.
- Prepare the environment: the environment in which the learning experience will take place, and its facilities, should be suitable arranged for that: ordered, made comfortable, with enough light, etc.
- Prepare the learners: the learners themselves should be prepared to the activity by providing them an overview of what will happen, expressing the goals, raising interest, etc.
- Provide the learning experience: finally, the learning experience can be delivered.

Require Learner Participation

This phase is not temporally sequential with the previous one, rather represents a particular care to have during the enactment of the learning experience. The idea is that learners should be actively and individually involved into the activity, and not just be passive "audience" of the teacher, or of 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 should as well be a matter of concern, in order to let learners have the time to process the information.

Evaluate and Revise

Like in ADDIE, the last phase comprehends an evaluation of the learning experience and the revision of the whole process.

Insightfully, ASSURE indicates that the process of evaluation should not be thought of as 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, we could represent the ASSURE model as follows in Figure 5, which represents the evaluation and revision phase as a continuing task that follows the whole process and gives it a cyclic structure.

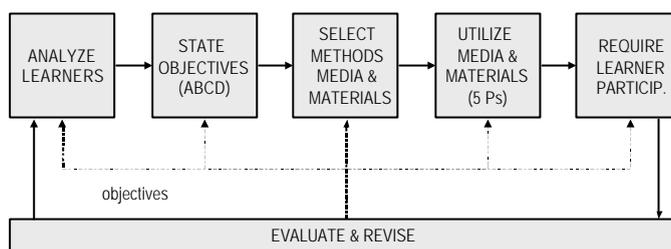


Figure 5 - The ASSURE model

The ASSURE model is a media-oriented evolution of the ADDIE models. 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. The perspective on the design process also remains the same: once more ASSURE models the design process itself, and not the object of design.

We point out a possible misunderstanding that could be generated by the wording used in this model. The Select phase concerns methods, media and materials. The choice of the terms is probably due to the desire to make it easy to recall (3 Ms); nevertheless, the word method may sound strange, as it does not include an overall strategy, the holistic element that provides unity to the whole educational environment.

The first two models were strictly related and in their row there are many others classroom-oriented models that address the phases for a correct design process. The next three models we selected have different focus and perspective, and are consequently not directly comparable with the previous two. Rather, the designer could see them as complementary tools.

ARCS

While ADDIE and ASSURE are specifically focused on the design activity and the design layer, ARCS (like the following Nine Events and Landamatics) also addresses the layer of procedures.

Instead of addressing the issue of a successful learning experience *tout-court*, Keller focused on a specific issue and developed the ARCS model as a model for motivational design (Keller 1983; Keller & Suzuki 1988). It is particularly interesting as motivation is a fundamental condition for successful learning, and the ARCS model is one of the few models specifically developed for addressing this issue.

The expectancy-value theory (see e.g. Vroom 1964) defines *effort* as the major measurable motivational outcome. For an effort to occur in order to accomplish a task, two main conditions should subsist:

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

The ARCS model translates this idea into four characteristics that a learning experience should have in order to make and keep learners motivated, i.e. to engage them actively (and intentionally) into the learning task. Once more, ARCS is an acronym of its elements, which are the following:

1. Attention
2. Relevance
3. Confidence
4. Satisfaction

In the following paragraphs they are addressed with more detail.

Attention

The first goal of a teacher is getting the learners' attention, and keeping it all along the instruction. Attention is a precondition for learning, as it is the expression of the intentionality that is the basis for any activity. When attention is lacking, even the most interesting things just pass over without leaving a trace.

Gaining and keeping attention can play on three main dimensions:

1. *Perceptual arousal* means raising the attention through presenting exceptional or attracting sensory stimuli, such as a strange picture, a video, an unexpected action, an object, etc.
2. *Inquiry arousal* means to address the learners' intelligence with some puzzling issue.
3. *Variation* is the third dimension, and consists in changing relatively often the presentation method or the activity type, in order to avoid the establishment of "boring" routines.

The particular strategies presented by Keller for attention arousal are using of concrete examples, presenting incongruities or conflicts, using humor, varying the presentation media, enhancing participation and teaming, inquiring students and posing open issues.

Relevance

Once that the door of attention is open, the instructor's task is to let the learners perceive the relevance of the proposed learning activity, i.e. to reveal that what is going to be learnt will have a positive impact on their life, and is something that matters. Showing relevance means expressing the answer to "What is in it for me?"

The ARCS model proposes three main points concerning relevance:

1. *Goal orientation*, i.e. declaring and explaining the instruction's goals to the learners in a way which is meaningful to them.
2. *Motive matching*, i.e. matching the content or activities to the motives and needs of the learners.
3. *Familiarity*, i.e. present content in a way that is understandable to the learners, so that it is easy to relate to their own experiences, which are the only ground on which relevance can grow.

Along with that, ARCS proposes six strategies that detail the three points above:

1. *Experience*: the instructor may show the learners how the new learning will be constructed and exploit their previous experience, so that the new acquisition may get a meaning in the existing context.
2. *Present worth*: the motivation for learning is much higher if the thing 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 future is seldom a positive context of relevance if compared to a real present.
3. *Future usefulness*: the impact that the new learning will have on the future activities is a key for relevance, as can provide the openness for teaching not just on-demand (present worth), but also having in mind future evolutions and possibilities.
4. *Needs matching*: the analysis of the learners proposed by ADDIE and ASSURE should focus also on the learners' needs perceived by the learners themselves. If the learning activity is proposed as an answer to a particular but strongly perceived need, motivation will keep high all through the process.
5. *Modeling*: having a living example, e.g. an alumni, as a "result" of the learning process, is a way of making relevance concrete, of providing an embodiment of the knowledge to be acquired and to make it (hopefully) desirable.
6. *Choice*: the learners may feel more involved in learning if they have at least a partial control over it, e.g. choosing (maybe with guidance) a particular method, or a specific personal objective.

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, and is the precondition for a real involvement in the action.

Confidence

We may now suppose to have attentive and involved learners that really perceive the relevance of the learning experience for their situations. Still, involvement may be hindered by uncertainty, by the fear to make errors, to fail an exercise or to miss an answer in front of the class. It is the second element of the expectancy-value theory: “the actor must believe he/she can succeed at the task”. Taking care of confidence means trying to make these obstacles the least important things in a learning environment, to make learners feel at ease in the situation. ARCS proposes four guidelines.

1. *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 to the learners. The basic idea is to try to put the learners in a situation where he/she always possesses the learning requirements for the next step.
2. *Realistic expectations*: the outcome expected from the learners should be perceived as realistic from the learners themselves, in terms of amount of skill and labor to be expected. This to avoid the situation in which learners do not even start engaging in the work as they think they will never succeed because of too high expectations.
3. *Learner controlled elements*: learners should be in control of their product outcomes, and should be made able to predict the result of their activity, also in terms of evaluation. The case of “I did everything the instructor said, but failed the test” should be avoided. Moreover, the management of the personal activity should be free, of course adequately to the grade and effective independence of each single learner.
4. *Opportunities for increased learner independence*: 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 and acquire reliance in what they have learnt.

Satisfaction

Finally, learners should get some satisfaction at the end of the learning experience, once they achieved the desired goals for the educational environment. It is important as a reward assessing the effective learning that took place, and, as usual, should be tailored to the specific grade: a game or entertainment form, a mark, a certificate, a special prize, etc.

Satisfaction can be provided through

1. *Intrinsic reinforcements*, i.e. by expressing the enjoyment of the learning experience in itself.

2. *Extrinsic reinforcements*, i.e. by providing awards, certificates or encouragements (the mark!).
3. *Equity*, i.e. by maintaining consistent standards and consequences for success, and informing learners about them before the evaluation takes place.

Although defined as special attentions in designing an educational environment, the four ARCS elements can also be intended as steps in a sequential motivational process to be achieved within the instruction.

Gagne's Nine Events of Instruction

A personality who much influenced the development of Instructional Design is Robert Gagné. His works address almost all issues of this discipline, proposing both theoretical insights and practical solutions to many of them. The two main contributions of Gagné's are a taxonomy of learning outcomes and the so-called nine events of instruction theory⁶. The taxonomy will be presented in the last part of this report, while the following paragraphs introduce the nine events theory.

According to this theory (see e.g. Gagné 1962; Gagné, Briggs & Wager 1992), there are nine events that activate an effective learning process in any educational environment. Descriptively, they represent what occurs when we learn something, the happenings necessary to make learning actually take place; prescriptively, they represent blueprint for the design of a single educational activity, a set of conditions of learning.

The nine events are the following:

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* to be possible. The indications proposed by Keller may provide enough information about this point.
2. *Inform learner of objectives*: learners should be informed 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 of the learners' is important to develop a commitment and to create trust.
4. *Present stimulus material*: all learning starts from an external stimulus, be it 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.

⁶ Gagné also proposed an ADDIE-style model for instructional design, which is not included here.

5. *Provide learner guidance*: once the process of learning is started, the process of meaning creation or *semantic encoding* can be guided and supported by the teacher. It is the concept of scaffolding, of providing an environment and tools 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 respond to a task., to pass definitely to an active role in the educational environment.
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 provides a final and official, maybe standard, evaluation of the learning outcome 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*, i.e. the transposition of the new learning in to the real activity environment, be it a professional environment or a further learning activity. An educational activity should include devices or sub-activity that reinforce the retention of learning and its effective application, in order to meet the real educational goals.

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 we encountered presenting the ARCS model in the previous pages, and it may be worthwhile to make a short comparison between the two of them, as we have tried to do in the following Figure:

	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 6 - A comparison between Gagné's nine events and ARCS

The gray areas indicate where the events can be related to the four elements in ARCS: e.g. 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 the elements cannot be said to be congruent, nor would 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 plays a key role in learning. While ARCS focuses on the internal factors that enhance motivation, Gagné describes the steps the instructor has to go through for fostering it, and calls them *events*, i.e. occurrences that produce a commitment in the learner.

We point out here that although all authors recognize motivation as a key element in learning, it is difficult to find models that address the issue on a broader level, i.e. not in classroom-oriented models but in system-oriented models.

Landamatics

The last models selected in this section 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 developed in Landa 1976; then e.g. Landa 1983 and Landa 1993) is concerned with teaching and learning cognitive strategies or methods, and its main idea is analyzing an expert's way of solving a problem or performing a procedure, breaking it down to units and configure an instructional unit. We selected this theory because it is particularly interesting as it is extremely formal and takes a strong epistemological perspective on the nature of cognitive strategies and procedures.

The starting point is that in order to solve problems, and to teach to solve them, one may move from observing an expert performing that. But of course, learners should be taught not only the factual information that expert possesses, but also the algorithm and heuristic strategies they apply. In fact:

"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)

The point is that the problem solving process by an expert is often unconscious, unexplained and somehow perceived as "natural". The instructor's goal is bringing novice students to this expert-level competence, and he/she 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 an example, e.g. preparing handmade *tortelli* with meat. Every expert – in our case, typically a grandmother – able to do this would not probably be able to express all the elements in the process, but would say put in the bowl "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 filling, 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. After that the method can be reprised and its critically revised for deepening its generality and broadening its scope.

A graphical representation of the method is sketched in Figure 7:

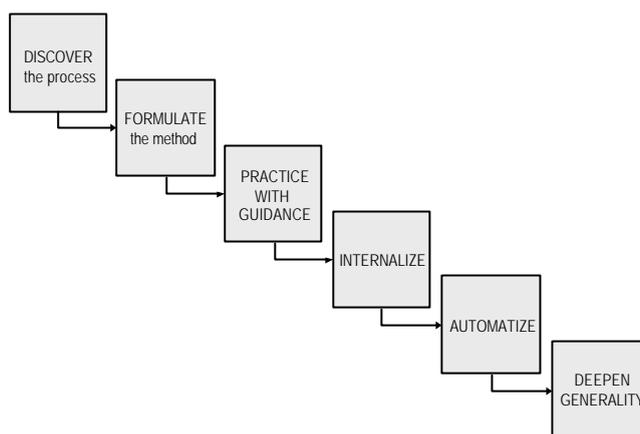


Figure 7 - a diagram of Landamatics

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 redesign according to the specific situation in order to be effective). While for the former 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).

The basic elements of this kind of approach are a precise hypothesis on the type of knowledge and expected learning outcome and a very detailed process toward the definition of an instructional procedure. Following our grid, Landamatics is concerned not only with the layers of design and procedures, but also brings a definite hypothesis on the level of the approach.

Material Development-Oriented Models

The second kind of models described by Gustafson and Branch’s taxonomy considers models specifically focused on the development of instructional materials, i.e. on the production of 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. They therefore consider situations in which a development

team is at work with a high degree of technological complexity. They require fine design and technical skills. Generally, the requirement analysis is not included in such models, as it is supposed to be completed during the instructional design process. One strength point of these models is the production of highly distributable and reusable learning materials and tools.

If we exclude the Learning Object trend, 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 graphical design, text editing, and multimedia or software development. It is in fact an open issue if education is a so specific domain to justify the definition of on-purpose development methods.

In order to provide some interpretation key and from a general point of view, we can divide teaching and learning materials into three great groups:

1. Content materials as exposition support, for self-study or in any case presenting some specific content (e.g. a theory, a case study, etc.).
2. Interaction tools materials, i.e. materials designed for stimulating or supporting an activity (e.g. group work) or a communication flow (a forum, a chat-line, etc.).
3. Tools, i.e. instruments that are necessary for performing an activity (e.g. a microscope, glue and scissors, etc.).

While interaction-oriented materials can be defined tout-court as communication tools, and can exploit development methods derived from other fields, it is not the same for content materials. These latter, and it is clear if we talk of multimedia or books, belong to the tradition of formative communication, and have always been a specialist's work. For these reasons material-development models actually exist only for the latter kind of materials.

Moreover, we have to mention that the issue of learning materials has become particularly relevant with new media in education and distant learning. On the one side new media offer before unthinkable possibilities (multimedia, interactivity, on-time distribution via the network, etc.); on the other, distant 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 (of hypermedia).

CADMOS-D

One trend in educational material development is the specification 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 *de facto* the high-level standard in this field. W2000 is an evolution of HDM (Hypermedia Design Model, which was actually borne before UML was released, Garzotto 1993) is a conceptual model for the design of content-oriented hypermedia applications. One trial for specializing such languages for e-learning software development is

CADMOS-D, developed in (Retalis, Papasalouros & Skordalakis 2002) and (Psaromiligkos & Retalis 2002).

The object of CADMOS-D are Web-based educational applications – 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 a design process structure taken from HDM, thus decomposing the design process in three main phases, represented in Figure 8.

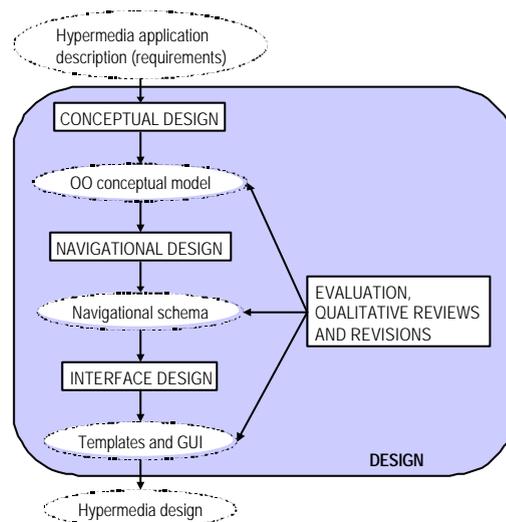


Figure 8 -The CADMOS-D design process

The design process (represented by the rounded gray square) is composed by three steps (represented by white squares), each producing a specific output (in the ellipses):

1. The *conceptual design* phase 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. The *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, the *interface design* copes with defining the user interface and the actual Web pages.

The greatest effort done by the developers of CADMOS-D have been aimed at developing an UML-like meta-model for the conceptual design. The meta-model would allow educational software developers to define with great detail their products, 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)

We will not reproduce here the meta-model schemas, as they are legible only for technical people and are not necessary for the goals of this state-of-the-art review; they are available e.g. 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 brings to low-level specifications. Any example of modeling is clearly unreadable for a teacher or a software unskilled educational designer, as it presupposes knowledge of the UML notation standards. Moreover, documenting the design process with this model is not economic, as requires a huge investment in terms of time in order to get to the required level of detail. This does not mean it is not useful – rather that is it useful *outside* the instructional design process, namely in the case in which an instructional designer let some software developers to produce an application for which he/she only provides the requirements.

Moreover, we would like to add two short remarks, that we believe should be taken into account for the development of any educational application development related 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 situations, 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 within another discussion thread in the e-learning domain: the development of metadata for learning objects.

The Learning Objects Trend

A new trend in educational technology that will probably influence the instructional design practice is the current research on Learning Objects. This trend cannot be considered as part of the discipline of Instructional Design; nevertheless, given its success, the entity of

investments and its current evolution, is something with which instructional designers will have to cope.

The basic idea (which was originally related to that of semantic Web) is to develop a metadata⁷ 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.). The purpose of metadata is that of fostering (or making possible) the reuse and exchange of instructional resources. A learning object should be consequently context-independent and self-contained, i.e. it should be usable in a different course than the one for which it was originally developed, and be integrable with other learning objects, eventually produced by different people in a different institution.

The Learning Object domain is currently in great development, and is growing more and more extended. The short review proposed here is no way exhaustive, but provides some general guidelines and the necessary references for further information.

LTSC Learning Object model (LOM)

A first attempt to approaching the Learning Object issue was made by the Learning Technology Standardization Committee of the IEEE (LTSC), which proposed a general model that remained as reference for all other developments, also in other organizations. LTSC defined learning object as “any entity, digital or non-digital, usable for learning, practice or instructional activities”.

LTSC goals are the following:

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

⁷ 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, last visit 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.” (Taken from <http://www.library.wisc.edu/data/GIS/whatmeta.htm>, last visit February 2003).

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), a reference model that other standardizing initiatives in this field considered as main reference (LTSC 2001). We will not propose here the whole model; 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*: include the development history and the current status of the learning object (finished, revised, etc.).
- *Meta-metadata*: provide information about the metadata standard used for specifying the metadata.
- *Technical*: gathers information about the technical features of the learning objects and the technical requirements for using it (e.g. a specific media player).
- *Educational*: summarizes the educational features of the learning objects, e.g. its suitability in a particular learning strategy.
- *Copyright*: express the terms of use of the learning object.
- *Relation*: defines if the learning object has relationships with other learning objects, e.g. was originally thought to be a part of a specific sequence.
- *Annotation*: is 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.

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 is part of the EDUCOM consortium, and is composed by several American higher education institutions along with payers in the e-learning 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, and addressing also the application side of it. The implementation strategy proposed by IMS sees XML as the language for metadata development (the so-called XML binding).

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 objects.
- *IMS Content Packaging*, concerning the development of “units of learning”.
- *IMS Simple Sequencing*, concerning the sequencing of resources within learning object and sequencing more learning objects and services within a learning environment.
- *IMS Question and Test Interoperability*, concerning assessment resources.

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 Learning Design*, which describes a whole learning environments (this will be addressed later on in this Report).
- *IMS Reusable Definition of Competency or Educational Objective*, which deals with the expression of learning goals (this will be addressed later on too).
- *IMS Enterprise*, for describing the organization that hosts the educational environment.

Each specification of IMS's comes with three main documents:

- The *Information Model*, which provides a description of the conceptual model (metadata categories, names and structure) of the proposed standard.
- The *Meta-data Best Practice and Implementation Guide*, which is a practice guide about how an application can exploit metadata and the specific metadata elements specified.
- Finally, the *XML Binding*, which is a guide for the development of digital format learning objects (respectively environments or other entities) with the XML binding, with templates and examples.

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 any possible kind 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.

AICC guidelines and recommendations are collected in a number of documents, divided for areas of interest. AICC documents can be of three kinds:

- The *AICC Guidelines and Recommendations (AGR)* represent the official AICC communication for each specific area. E.g. AGR-004 describes the recommendations for the acquisition and usage of CBT software distributed to the students.
- The *Technical Reports* specify technical details underlying an AGR, and are produced by sub-committees (e.g. CMI for Computer Managed Instruction, COM for Communications or CRS for Courseware Technology, etc.).
- The *working documents* that are part of work-in-progress activity.

The main achievement of AICC, exploited also within the SCORM standard (see below), is the CMI - Computer Managed Instruction, a software application that selects and sequences content presentation and learning activity 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 his/her 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 e-learning platform, which represents the context in which a single learners 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 and probably most advanced initiative concerning learning objects was proposed by the Advanced Distributed Learning organization, 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 fix the goals of SCORM, ADL defined four main features required for e-learning 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 of an application platform 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.

The SCORM specifications are composed by three main elements:

- A general part stating the composition of the organization and its goals.
- Guidelines for the identification and aggregation of learning objects. Learning objects are here described according to the LTSC LOM specification, and are designed on three main levels:
 - Learning object: a self-contained learning resource (e.g. a set of Web pages);
 - Asset: a single file within a Learning Object (e.g. a GIF file image)
 - Aggregation: a structured set of Learning Objects
- The specifications of a runtime environment, which reprise 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 object standards. Nevertheless, we have introduced the topic here 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 an 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 not 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 the connections among that, to the presence of a continuous flow of activity producing one consistent meaning.

Moreover, it is a matter of cost. Coding metadata is a time-consuming task. We never wrote of dimensions, but the writing metadata for a SCORM or IMS learning object means filling more than 80 descriptors. Is that worth within the perspective of course development? Clearly, it does if reuse or exchange (selling?) is considered, but this implies a new perspective in design, and a new attitude in the organizations producing instruction⁸.

Now let's take for a moment the perspective of someone retrieving from an online "e-learning 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?

We added these remarks not because we are skeptical with regard with learning objects – E²ML is learning-object compliant – but for pointing out that a learning content standard is not a mere technical issue, rather that it implies great changes on the design as well as on the organizational levels.

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 & Nejd1 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 in fact the development of a whole course or even curriculum, with a huge investment in terms of resources by an interdisciplinary and skilled 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 a finite and high-quality product. From the technology standpoint, the complexity can be high, and materials are usually developed within the process.

The complexity of system-oriented models is the reason why their number is tinier. We have selected three of the major models, presented in the following pages.

The Dick, Carey & Carey Model

The Dick, Carey & Carey model (also referenced by many as the Dick & Carey model) is the result of a long-lasting refinement work through a number of edition of their main textbook (Dick, Carey & Carey 5th ed. 1996, 6th ed. 2001).

They present instructional design as a systemic activity, a system being "a set of interrelated parts, all of which work together toward a defined goal" (Dick, Carey & Carey 1996, p.3). In order to consider all the parts in the correct order, and with the correct

⁸ An extremely positive example of this new attitude can be found in the MIT open course project (MIT 2003)

relationships, this model proposes a design process articulated in 10 phases, as sketched in Figure 9:

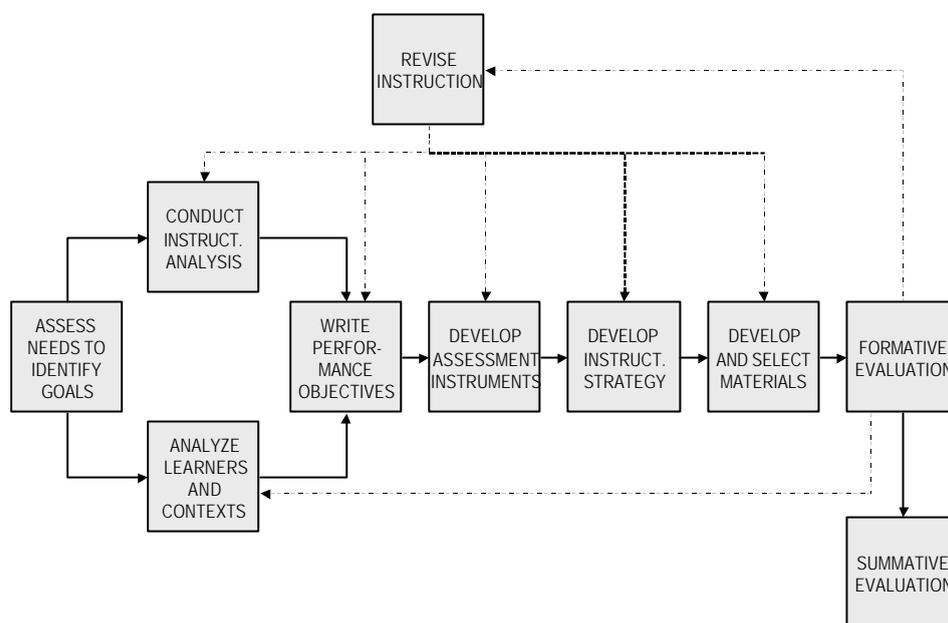


Figure 9 - The Dick & Carey Model

The whole process is tailored to course development, and is supposed to be conducted by an interdisciplinary team (subject experts, instructional designers, media and material developers, etc.) with great investments. Each phase takes care of 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.

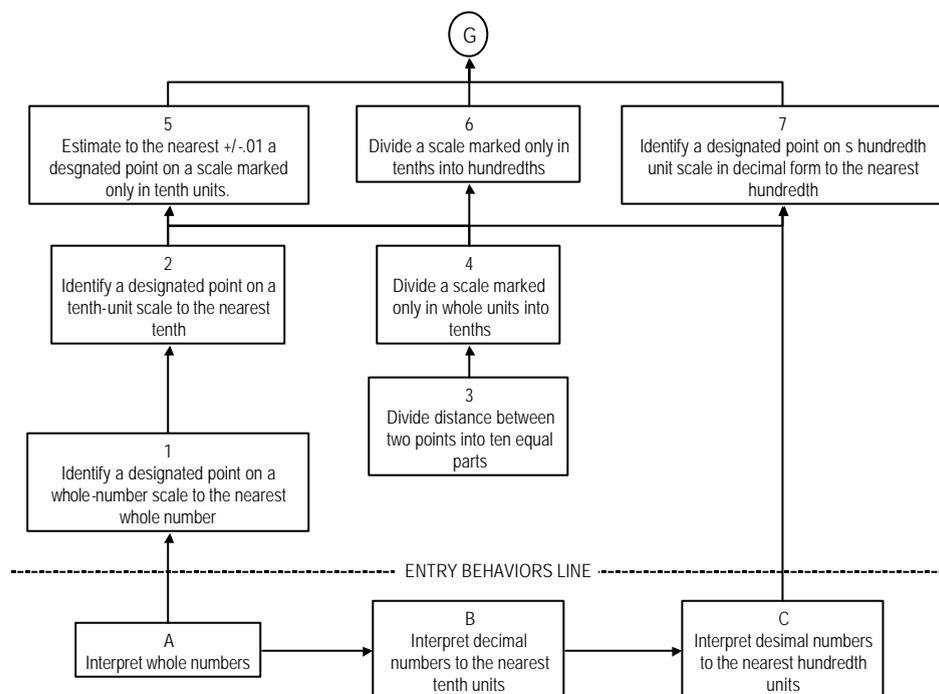
Requirement Analysis

The first main step in the design process is requirements analysis, i.e. 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 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 issue at stake for which instruction is supposed to be an effective solution.

2. *Conduct instructional analysis.* The instructional analysis consists in analyzing the skill gap and determining the sub-skills necessary for that goal. Dick & 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, i.e. skills that are presupposed for entering the instruction. The process may be specialized for different kind 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 of a competence is shown in the Figure below for the goal “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” (Dick, Carey & Carey 1996, p. 72). The main goal is marked as G in the Figure.



This method, which will be discussed again later on in a different context, is indeed a tool for a detailed analysis; on the other side, complex goals require a great effort in order to be expressed as such. Nevertheless, the importance that Dick, Carey and Carey assign to instructional goal analysis (and that we completely share) is paramount, and the resources invested in goal analysis will result in the overall quality and adequacy of instruction to the real needs. The output of this phase is therefore a complete and detailed map of the instructional goals, its sub-skills and the entry behaviors.

3. *Analyze learners and contexts.* After having determined what to teach, the analysis focuses on who we be taught. The model proposes three elements:

- a. The learners, i.e. their personal and social characteristics, their prior knowledge of the topic area and their entry behaviors, their attitude towards the instruction (i.e. toward the content, the potential delivery system, the organization, and their general learning preferences and motivation).
- b. The learning context, i.e. the number and nature of sites, their compatibility with the instructional needs and with the learners' needs (i.e. opening hours, facilities, etc.), and the feasibility for simulating the performance context.
- c. The performance context, i.e. the context in which the new learning will be put into place in "real life": the managerial/supervisory support, the physical aspects, the social aspects and the relevance of the new skills to the context.

These elements are necessary for determining the perspective of the instruction, and to provide the designer with information about the real learners and their world. The instruments for this analysis are interviews with learners (with single learners, small groups, or wide surveys) and managers, and gathering 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 requirement analysis step is concluded by formalizing the results into performance objectives, which 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 (e.g. manage a group discussion), behavioral objectives should only describe specific observable performances (e.g. 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 that performance. The output of this phase is a formalization of the objectives, which are turned into observable performances and defined with the condition and degree attributes.

Instruction Development

In the development of the instruction we meet one of the characteristic differences of system-oriented design models with respect to classroom-oriented ones. The scope of system-oriented requires that they consider assessment as a major concern of instruction. The idea of the Dick, Carey & Carey model is that the definition of the assessment is the pivot point for connecting analysis and design. The first phase we meet in development in fact is the production of assessment instruments: knowing how learners will be evaluated is the key element for understanding how the instruction will bring them to be successful. To that phase follow in fact the development of an instructional strategy and then of the learning materials.

If the design process is structured this way, the translation of goals into assessment items is one of the most delicate activities: it is often not easy to effectively assess the acquisition of a goal in an artificial learning environment (think e.g. of any attitude 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 some guidelines are also provided for that concerning 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 their actual 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 2001, 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. Third, 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 the following figure.

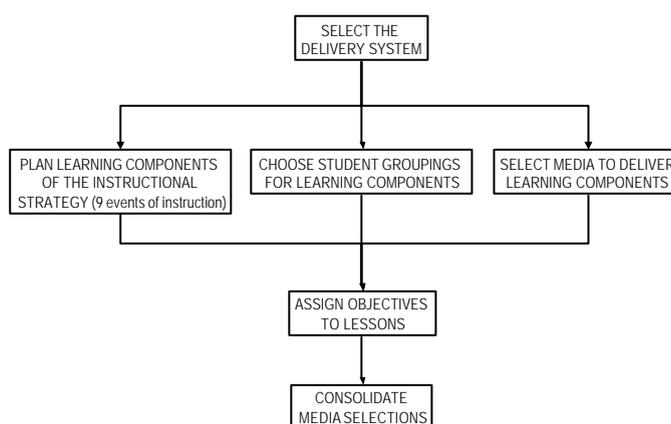


Figure 10 - A flowchart representation of the development of an instructional strategy

The strategy should be tailored to the specific kind of learners and to the kind 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 necessary media.

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 assessed 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 us that “the first step in adoption of a new technology are usually attempts to replicate the features of the old technology” (Dick, Carey & Carey 2001, 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, i.e. 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 major step in the design process according to the Dick, Carey & Carey model concerns the evaluation of the developed instruction and its revision for further editions. The phases concerned here are the following three:

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). The designer conducts formative evaluation involving 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, 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 about improving the instruction to fit better to the real needs of the stakeholders.

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 on 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. We would like to point out here that, as education is a complex event, no definite indication of improvement can be considered a sure solution of any problem encountered during the instruction. While the instructor is committed do his/her 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 our best, revised and proofed 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 results in a measure of the effectiveness of the instruction. 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 outcome of the instruction.

Summative evaluation is a final consideration of the overall quality of the instruction not *per se*, but in relation to the organizational context whose needs have generated it.

The Dick, Carey and Carey model can be considered the state-of-the-art model for instructional design. As clearly resulted from this brief presentation, it is an incredibly complex model, developed with the aim of guiding the instructional designer in its activity 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 traditional teacher.

Moreover, 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 two following models we will introduce in the next pages do not differ much from the Dick, Carey and Carey model in their essence, rather present different perspectives.

Smith & Ragan's Instructional Design

Patricia L. Smith and Tillman J. Ragan's *Instructional Design* (Smith & Ragan 1993, 2nd ed. 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 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 (i.e. other models) are actually exploited by designers according to their position on the approach layer.

Smith & Ragan do not quote Richards & Rodgers, but focus their attention on design and educational principles rather than on procedures, keeping a practical theoretical eclecticism. From a technical standpoint, they assume the Dick, Carey and Carey model as general framework (thus considering analysis, design, evaluation and revision), integrating it with other contributions and with their own experience. For this reason we are not going to present the model's phases in detail. The interesting focus and original contribution is rather on instructional strategies, deepening how different learning goals can be achieved.

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 we found theories, i.e. "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 moment within the design process where differences can be observed is the definition of an instructional strategy.

One example of that, accurately discussed, is generative vs. supplantive strategies. The issue could be expressed as the dilemma between how much a strategy should let the

learners do the job, 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 (supplative). 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 supplative 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 key for guiding the designer.

Instructional Strategies

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

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

The learning objectives for which a strategies are presented are taken from Gagné's taxonomy (introduced in detail later on in this report), and are the following⁹:

1. Problem solving
2. Declarative knowledge
3. Concept learning
4. Principle learning
5. Procedures learning
6. Cognitive strategies
7. Attitude change, motivation and interest
8. Psychomotor skill

⁹ 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).

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 used for that. Moreover, particular insights on critical details of sub-strategies are presented. The text also provides a great number of examples that embody the principle presented, along with accurate references.

Smith and Ragan *Instructional Design* is therefore a text that summarizes a number of prior contributions in the field of Instructional Design with an original and interesting perspective, focusing on principles and strategies. This means introducing a new way of teaching instructional design, as well as stressing the professional importance of the general understanding of education also in a technically oriented job as design is.

Greer's Instructional Design Project Management

An interesting contribution to Instructional Design comes from a book by Michael Greer, *ID project management* (Greer 1992). This book presents the same process of system-oriented design from the manager's perspective, that should cope with limited resources, time and cost constraints, and has decisions as milestones.

"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".

(Taken from www.michaelgreer.com, last visit November 2002)

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 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 e-learning present a number of open issues. Although they will be not considered here, they will remain on the background of this more technical 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 11 presents an overview sketch of the ten-step model, grouped into three main phases:

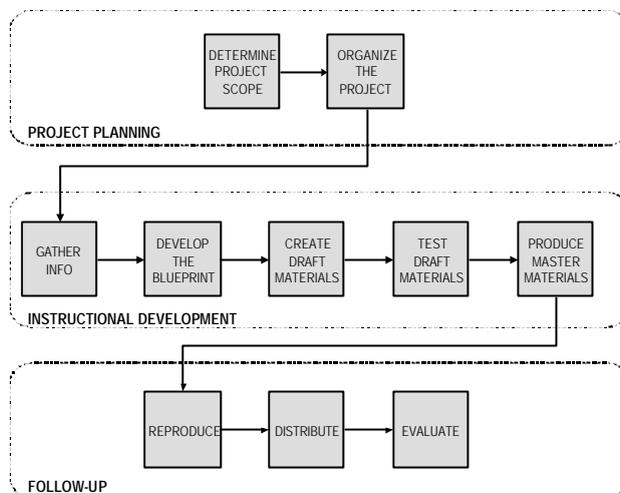


Figure 11 - Greer's model

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 detail¹⁰, presenting activities and results for each of them.

Phase I: Project Planning

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

1. *Step 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 his/her commitment to the project and its scope.
 - 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.
 - Results: preliminary materials specifications; project schedule and/or time estimate; budget and/or cost estimate.
2. *Step 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 project scope are still valid. In addition, it requires that detailed plans be developed, thus helping to lay the groundwork for a successful project.

¹⁰ This presentation of Greer's model was adapted from <http://www.michaelgreer.com/idpm-mdl.htm> (last visit April 2003).

- 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.
- 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 understated success element in any design project.

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. *Step 3. Gather Information:* Step 3 corresponds to the familiar "requirements analysis". From a (a little bit "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".

- 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, gather that information in an effective manner. Formal task, job, or content analyses may be also conducted.
- Results: Detailed information is gathered concerning:
 1. The target audience of the training
 2. The trainees' relevant work environment
 3. The specific tasks which must be learned
 4. Technical details about the course content

4. *Step 4. Develop the Blueprint:* The blueprint is intended as a set of design specifications that allows all relevant reviewers to look at course content and strategy before energy and resources are actually expended 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. *Step 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 if we include 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 costly activity in the instructional design 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. *Step 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 they were designed to work.
- 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. *Step 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. *Step 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. *Step 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. *Step 10. Evaluate:* according to Greer, the main purpose of evaluation is in fact 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 peculiar to this model that make it 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 material, but how to manage the production process. This stress, as we have already pointed out, 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 e-learning. The presence of steps concerning reproduction and distribution are also an indicator that the model is action-minded, and which not just to *design* education, rather actually put the program into place. 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 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, and who for this reason has deciding power. Clearly, in 90% of the situations, 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 considered 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 or of a course, and they are the ones who should be in the end satisfied with the designers' work¹¹.

IMS Learning Design

On February 14th, 2003 the mailing list of Learning Networks announced that four days before 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 the 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 Object standards, as presented some pages above, 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, the Learner Information Package and the Reusable Definition of Competency or Learning Objective. With Learning Design IMS completes a suite of formal tools that encompasses potentially the whole activity of the instructional designer.

This is the reason while we placed Learning Design among system-oriented models, but left Learning Objects among product-oriented models. While the latter concerns objects that could be exploited in learning, the former aims at representing the whole instruction.

Relevant issues for Learning Design

“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.”

¹¹ Another perspective from which the role of stakeholder becomes relevant is the evaluation of education. See e.g. Eppler & Mickeler 2003.

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

IMS addressed this concern through the development of the different specifications introduced above (in the Learning Object section). The specific issues IMS is trying to tackle with Learning Design are the following:

“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 in of 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)

Consistently with all the Learning Object metadata initiative, IMS 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. Further on we will verify the compatibility of the two models.

Objectives of Learning Design Specification

The objective of the Learning Design Specification is to provide a containment framework of elements that can describe any design of a teaching-learning process in a formal way. 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, pre-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 Model¹²

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 12.

¹² This part was adapted from (IMSa 2003, information model).

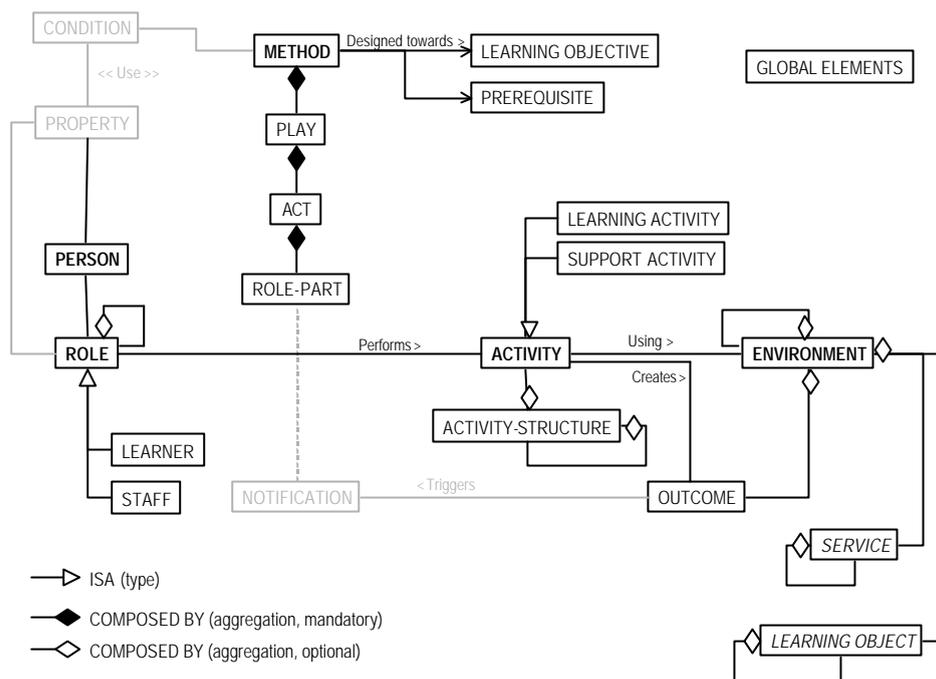


Figure 12 - IMS Learning Design Information Model (UML)

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 (grey 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 he/she 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*. Note: most of the concepts mentioned above are reflected in the information model, but some only exist at the conceptual level (person, outcome).

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 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 parallel¹³.

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 [LD1], 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, etcetera. 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.).

¹³ 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).

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, 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 a standardization organization) will be the development of applications that make the exploitation of these standards simple and effective.

Expressing learning goals

Like in any design process, the statement of the learning objectives is one of the most important and deciding moment of instructional design, as objectives represent a description of the desired end point, of 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. With education the situation is more complicated. First, where there was only an owner, we now usually find 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 learner's and stakeholder's 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, and a thorough discussion of that is always included in the main referenced texts in the literature. Classifying goals and matching goal types to instructional strategies is indeed the most difficult step in the whole design process, as it is where the designer takes the risk of converting the analysis into determined objectives.

The last part of this report is therefore focused on this particular phase of the design process. Again, the proposed review is forcedly limited and does not take into account all relevant literature on the topic¹⁴, the idea being rather proposing an interpretative key.

Some examples and issues

Before coming to the actual presentation of models, let us introduce a couple of examples that may show how tricky it is, trying to describe human knowledge.

Think of a statement like "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", which could be part of a course in Statistics or Logics for students in the Human Sciences. The point here is that, if the goals should be achieved effectively and efficiently, the instructional designer must know what kind of

¹⁴ We deal here with the *expression* 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.

knowledge is at stake here, in order to identify and implement an appropriate instructional strategy. Now, the mathematical definition of *function* is a typical *defined concept*, according to Gagné (see below). The proof for a person possessing a clear concept is the ability to provide a definition, which is not our case here. Should we then consider the definition of function a fact? It is indeed at least weird.

And what about “I want the student to see what is a classic Democracy” – 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.

Lastly, think of a procedure, which is indeed a set of known facts, of situation-grasping abilities, and heuristic principles. Yet, there is something more in learning a procedure (i.e. being able to describe it), and in applying it to real situation (i.e. change behavior): the learner’s decision to use it. Think of the following example: “I want my employees to know how they should *not* behave in such situations”. This is a procedure goal where a procedure should be known and evaluated, but should *not* be applied. The same can be said for learning strategies (learning-to-learn) and attitudes, such as “being collaborative”. One step would be surely knowing that the attitude “be collaborative” exists, secondly being able to describe it; then value it (“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.

While any instructor has a more or less defined insight of the learning goals for his/her activity, we hope that these brief examples show some issues that arise when trying to formulate a more precise definition. A definition that is indeed necessary when the development of e.g. a course is assigned to a team.

Bloom’s Taxonomy of Learning Goals

In 1950s Benjamin Bloom (Bloom et Al. 1956) proposed a first and widely known definition of different types of learning outcomes (already introduced in the beginning of the report). Bloom distinguished two domains of learning¹⁵:

1. The *cognitive domain*, gathering intellectual knowledge and cognitive skills such as Mathematics or Sociology learning;
2. The *affective domain*, gathering values, interests, attitudes, opinions, appreciations, values, emotional sets and what we would today call emotional intelligence such as being attentive;

¹⁵ Bloom's research group did not develop in-depth categories for another domain they identified, the so-called psychomotor domain, claiming lack of experience in teaching these skills. Several authors proposed a completion, such as (Harrow 1972).

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).

In presenting the levels we also report the main verbs describing goals on each level. This will help figuring out what exactly is addressed in this model.

The cognitive domain

Bloom divides the cognitive domain into six levels, which are the following:

1. *Recall* of factual knowledge, which includes knowledge of terminology and specific facts; ways and means of dealing with specifics such as conventions, trends and sequences, classifications and categories, criteria, methodology; universals and abstractions in a field (principles and generalizations, theories and structures). The main verbs are defines, describes, enumerates, identifies, labels, lists, matches, names, reads, records, reproduces, selects, states, views.
2. *Comprehension*, i.e. grasping or understanding the meaning of information and relating it to one's experience. The main verbs are: classifies, cites, converts, describes, discusses, estimates, explains, generalizes, gives examples, makes sense out of, paraphrases, restates (in own words), summarizes, traces, understands.
3. *Application*, i.e. the use of previously learned information in new and concrete situations to solve problems. Here is where knowledge is actually applied creatively. The main verbs are: acts, administers, articulates, assesses, charts, collects, computes, constructs, contributes, controls, determines, develops, discovers, establishes, extends, implements, includes, informs, instructs, participates, predicts, prepares, preserves, produces, projects, provides, relates, reports, shows, solves, teaches, transfers, uses, utilizes.
4. *Analysis*, i.e. the breaking down of informational materials into their component parts, examining and trying to understand the organizational structure of such information to develop divergent conclusions by identifying motives or causes, making inferences, and/or finding evidence to support generalizations. The main verbs are: breaks down, correlates, diagrams, differentiates, discriminates, distinguishes, focuses, illustrates, infers, limits, outlines, points out, prioritizes, recognizes, separates, subdivides.
5. *Synthesis*: i.e. 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 or original whole. The main verbs are: adapts, anticipates, categorizes, collaborates, combines, communicates, compares, compiles, composes, contrasts, creates, designs, devises, expresses, facilitates, formulates, generates, incorporates, individualizes, initiates, integrates, intervenes, models, modifies, negotiates, plans, progresses, rearranges, reconstructs, reinforces, reorganizes, revises, structures, substitutes, validates.

6. *Evaluation*, i.e. assessing the value (or the truthfulness) of knowledge based on experience. The main verbs are: appraises, compares & contrasts, concludes, criticizes, critiques, decides, defends, interprets, judges, justifies, reframes, supports.

The affective domain

The Affective Domain is organized in the following five levels:

1. *Receiving*, i.e. being able to attend to particular phenomena or stimuli being focused and attentive. Intended outcomes include the learner's awareness that a thing exists. The main verbs are acknowledge, attend, be aware, choose, describe, follow, give, hold, identify, listen, locate, name, receive, reply, select, show alertness, tolerate, use, view, watch.
2. *Responding*, i.e. actively reacting and participating. The main verbs here are: answers, assists, complies, discusses, helps, performs, practices, presents, reads, reports, writes.
3. *Valuing*, i.e. attaching a value to a particular object, phenomenon, or behavior. This may range from acceptance to commitment (e.g. assuming responsibility for the functioning of a group), varying for attitudes and appreciation. The main verbs are: differentiates, explains, initiates, justifies, proposes, shares.
4. *Organization*, i.e. 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". The main verbs here are: arranges, combines, compares, generalizes, integrates, modifies, organizes, synthesizes.
5. *Characterization (or internalization) of Value*, i.e. holding a value system and developing a characteristic "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. The main verbs are: acts, discriminates, displays, influences, listens, modifies, performs, practices, proposes, qualifies, questions, revises, serves, solves, verifies.

Bloom's taxonomy is important as it has served as reference point for several authors, and as it distinguishes and addresses two basic kinds of competencies – cognitive and affective.

Gagné's Taxonomy of Learning Outcomes

Another important classification schema for learning objectives was proposed by Gagné, another author that we have already met in this report. His taxonomy is articulated in five categories (also called *domains*) of knowledge.

1. *Verbal information*, which includes declarative knowledge, and the knowledge of facts, such as in “recall the names of the Italian president in the last 50 years” or “name the phases of hypermedia design”.
2. *Intellectual skills* comprise a whole set of mental abilities concerning concepts, including
 - a. Discriminations, i.e. distinguishing things according to features or belonging to categories.
 - b. Concrete concepts, i.e. categories created according to the physical characteristics of objects.
 - c. Defined concepts, i.e. abstract concepts such as *democracy* or *acid*.
 - d. Rules (principles, procedures and problem solving) identify our knowledge concerning actions and doing things.
3. *Cognitive strategies* describe a meta-cognition level, i.e. learning to learn, to approach a new situation or topic.
4. *Attitudes* are defined by Gagné as a mental state that predisposes a learner to choose to behave in a certain way, and are described as having affective, intellectual and behavioral components that interact.
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*, i.e. the combination different types of learning into a more general expertise.

Gagné and Bloom’s taxonomies clearly overlap, although a short remark should be done concerning the different perspective. While Bloom practically proposes a two-dimensional grid (domain and level), Gagné offers a more detailed division of domains, without entering in the detail of the degree of knowledge to which the instruction wishes to conduct the learners.

Determining the type of objective (and therefore of knowledge) is of course the major concern for the instructional designer, as it imposes a selection on the strategy. Nevertheless, in a real design process, the designer should also be concerned with the level of knowledge, defined as Bloom does, or more easily as “mastery degree” (see the previous discussion about assessment in the Dick, Carey & Carey model).

Merril’s grid

A last classification of learning outcomes proper to Instructional Design was proposed in (Merrill 1983), exactly as a two dimensional grid, with types and levels.

Merrill identified four types of learning outcomes, namely

1. *Facts*, i.e. declarative knowledge.

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

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

1. *Remember*, i.e. recalling a fact, concept, procedure or principle (know that the Capital city of Ticino is Bellinzona)
2. *Use*, i.e. recalling a fact when necessary and behaving according to it (if today is holiday, do not go for shopping), using a concept, applying a procedure or a principle (i.e. not just knowing what does it mean to drive safely, but actually drive that way).
3. *Find*, i.e. being able to discover new facts, define new concepts, modify or create a new procedure for a new set or subset of problems, define a principle.

Merrill's grid has the advantage of being simple (it defines only 4 types and 3 levels) and nevertheless precise (4x3 means 12 possible distinct outcomes).

IMS RDCEO

Another interesting contribution to the discussion was recently proposed by IMS, the same standardization organization that introduced Learning Design. IMS proposed a specification (which means an Information Model, the corresponding XML binding and Best Practice and Implementation Guide) for *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 and recognized catalogues of objectives. This would allow common reference for courses, making e.g. comparisons easier and unambiguous. 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 making objectives referenced.

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 the following code (which also can provide the flavor of what an XML definition of 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>

```

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 of it. This leaves the standard open to the integration with the taxonomies and grids mentioned above.

Objectives and Behavioral Objectives

The topic of how to express objectives once they have been located within a defined taxonomy deserves some short remark.

The idea of behavioral objective (or performance objective) was already in this report: it is a possible solution to the fact that learning is something by nature directly unobservable, thus making it difficult to assess if the instruction achieves its goals. 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 for collecting data about it, propose a significant sample population”.

For this purpose, lists of specific verbs that can be used to formulate behavioral objectives can be found among the Instructional Design tools (see e.g. Kizlik 2002).

Clearly, the two latter statements (which follow the ABCD guidelines introduced with ASSURE, see above) support the designer into creating test items, and generally to define a way in which to assess the success of instruction – with the first formulation this would not be so straightforward.

Nevertheless, a critical remark could be done, trying to distinguish the goal from the effects that we observe in order to confirm the achievement. “Learning what a sample

population is” means both to master 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. While on the one side, expressing goal in terms of behavioral objectives partially solves the issue of the evaluation of instruction, on the other may lead to an oversimplification, and also to a sense of frustration: what cannot be expressed as an observable behavior, cannot be taught? If we think of attitudes, this issue is particularly evident.

The definition of learning objectives is a primary topic in this field as it is probably the most deciding step in the design process. But another consideration increases its relevance. Classifying learning goals means having a way of distinguishing instructional strategies, i.e. to map a way of conducting education (the holistic principle of an educational environment) to the expected outcomes.

With this remark we leave place to some short conclusions, that will wrap up the way done up to now and open the further road.

Conclusions

Summary

About the Review

Concluding our review of the state of the art in Instructional Design, we would like to go back for a moment to the classification grid presented in the opening of this Report. The presentation of the different models was done proceeding along the *scope* axis (classroom-, product- and system-oriented), while we have left in the background the three layers (approach, design and procedures) and the three sub-disciplines (design, development, learning theories). As it is probably already clear, not all the presented models can be strictly classified with a one-scope, one-layer and one-discipline definition. Nevertheless, their major concern is surely design, if we exclude product-oriented models that are explicitly concerned with materials, and Greer's model, which brings the focus also on resources and constraints.

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 – and we hope this can be now appreciated – the whole discipline becomes lively thanks to the tension existing between the desire to understand teaching and learning (a matter of theories, and of approach) and striving to be practical (providing tools and procedures). Here is probably the fascinating side of it (as of any technical science, actually), 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, we hope that the interdisciplinary approach chosen, which brought to meet XML just beside motivational issues, did not resulted into a weird feeling, but in a widening of perspectives. The very art of teaching lives from mixing and cross-fertilizing different disciplines.

Specific Remarks

The first thing is that all models share a general stepwise approach to instructional design, which can be summarized in analysis, design and development, evaluation and revision.

Secondly, within and activity we identified several components: specific procedures (e.g. Landamatics), events that foster learning (Gagné) and motivation (e.g. ARCS).

Concerning learning goals or objectives, our review pointed out that their definition can happen by crossing two main dimensions, the type of learning (facts, concepts, procedures, etc.) and the level of achievement (recall, application, etc.).

Finally, we pointed out the new contribution that the technology world brought (or is bringing) to instructional design, the bridge being e-learning. We must mention here the fact 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 techie...)
2. The cultural crossover opens *per se* new perspectives for both worlds

Instructional Design and Teaching

A last small remark deserves a couple of lines in order to clearly state this report's perspective. Instructional Design is a part of the broader activity of teaching, even if, operatively, it may become a person or a team supporting an instructor.

The idea one may have after this state-of-the-art 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 will learn. A perfectly designed lecture may leave in 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 real 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 e.g. expressive power, but also in the freedom of thought and innovation that it leaves to its users¹⁶.

¹⁶ 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 following couple of statements: “the more formal, the more competence required to express freely” and “the more formal, the more powerful”.

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